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THE ROENTGEN DIAGNOSIS OF DESTRUCTIVE LESIONS OF THE KNEE JOINT AND ITS LIMITATIONS

AN EXPERIMENTAL STUDY[1]

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THE knee joint is one of the favored sites of destructive lesions, both inflammatory and tumorous. The roentgen study of this region, therefore, appears of profound importance. Based on a previously published analysis of its roentgen anatomy the subject of this paper is an experimental approach to its roentgen pathology. Here Chasin has shown the way. Others have attacked the same problem by a comparison of x-ray findings with those presented at operation or autopsy. Unfortunately it is in most cases only the advanced lesion which allows such a comparative study. Thus textbook descriptions of x-ray symptomatology often fit only the later stages of a disease. Systematic discussions of the roentgenology of early bone lesions are scant. In order to avoid empty speculations they would have to be based on pathologic studies as offered by animal experiments or on chance findings in human autopsies. Moreover, they require a thorough understanding of the physical and optical qualities of the roentgen rays in their application as a diagnostic method, as discussed in a previous paper (Lachmann and Whelan). But since the physical factors of density and dimensions play such an important rôle for x-ray appearance of bones we cannot make any direct use of experiments on animals, especially small laboratory animals in which the conditions are so different from man in regard to structure and diameter of bone.

Thus experiments on human skeletons seem to be a possible way to come to a better understanding of the x-ray diagnosis of bone lesions. This method was used for the first time in a systematic way by Chasin in 1928. By producing artificial defects in the spinal column he demonstrated the limitations of radiology as a diagnostic procedure. Later he followed that with studies on the knee and hip joint. In using this method we have to realize that we can imitate only the destructive phase of bone pathology, while accompanying reparative and productive processes are not adaptable to our procedure.[2] Figures 1-*A* and 1-*B* show the comparison of an actual destructive process in the patella and an artificial excavation in a macerated bone: the similarity is striking.

The method of Chasin requires exten-

[1] Aided by a grant from the Research Appropriation of the University of Oklahoma Medical School.

[2] In a previously published group of experiments (Lachmann and Whelan) we used the experimental approach of chemical decalcification to determine the limitations of radiology in the diagnosis of osteoporosis.

Fig. 1-*A*. Fig. 1-*B*. Fig. 2-*A*. Fig. 2-*B*.

Fig. 1-*A*. Roentgenogram of tuberculosis of the patella. (Taken from C. Blumensaat, "Die entzündlichen Erkrankungen der Kniescheibe." Ergebn. d. Chir. u. Orthop. Vol. **29**, 1936, Julius Springer, Berlin.)
Fig. 1-*B*. Artificial conoid defect in spongious matter of patella after bone has been split in sagittal plane. Diameter of base of defect 0.5 cm., depth 0.5 cm.
Fig. 2-*A*. Cortical defect on lateral surface of lateral condyle of femur on a knee surrounded by its muscles and ligaments (see arrow).
Fig. 2-*B*. Same knee after removal of soft structures and maceration of bone. Visibility of defect not markedly improved. Diameter of base of defect 0.5 cm., depth 0.5 cm.

sion and supplement in many respects. A systematic approach to the bones under discussion seems necessary. Defects have to be arranged in such a fashion that they cover all possibilities as to location and involve cortex and spongious layer separately and combined. The size of the excavations should be determined not only by measurements but also actually demonstrated by filling with contrast medium. The change in translucency of these defects, depending on their filling with paraffin or bone detritus, should be studied; also one should determine to what extent the soft structures surrounding bone and the mineral contents of the osseous tissue in the neighborhood of the defects influence their visibility. The experiments should be closely correlated with clinical destructive lesions, and attention should be directed to the importance of different projections for the demonstrability of these foci. Finally, an explanation for the different degrees of visibility of defects of the same size based on an x-ray anatomical analysis should be attempted.

EXPERIMENTAL

More than 190 defects were produced on various skeletons of the knee joint. For these experiments we used either macerated bones or the complete knee region of embalmed cadavers with all soft structures preserved, or knee joints with only the ligaments attached. The defects were produced by trephining the bone with bits of different size or by various instruments, as dental burrs and files, and involved the cortical, spongious, or both layers of the distal end of the femur, proximal end of the tibia, and patella. In the experiments on the patella the bone was always radiographed together with the underlying femur and tibia. When defects were produced on bones surrounded by soft structures, the bone was exposed by a few incisions and, if necessary, split. After the excavations on intended sites had been produced the soft structures were replaced and the skin sutured over them. All defects were filled with paraffin, which has approximately the same absorption coefficient as soft structures or wound exudate. The defects, if cortical, were disk-shaped; if deeper and involving the spongious layer, they were conoid-shaped. If the excavations were located in the spongious structures only, the bone was split before the experiment. The defects were always carefully measured and their

size finally demonstrated by roentgenographing them with an opaque mixture of barium and paraffin. The roentgenographs before and after trephining were taken under identical conditions of position and exposure.

The experiment on a given bone was usually started with a size at which we did not expect visibility on the x-ray film; then the excavation was gradually enlarged in all three dimensions and roentgenographed in intervals. Careful comparison with the film of the untreated control and with the films showing the defects filled with opaque material enabled us to recognize the faintest signs of destruction on the roentgenograph, stages which we would not expect to be visible in an actual clinical case. Cortical defects were gradually deepened toward and into the spongious part.

Fig. 3-*A*. Control roentgenogram of the distal end of a macerated femur in medial-lateral and anteroposterior view. Medial condyle to the left, lateral to the right in anteroposterior view.

In justification of our experiments on macerated bones a defect was produced on a knee surrounded by its muscles and ligaments and roentgenographed, the soft structures were then removed, the bones macerated and roentgenographed. The films are shown in Figures 2-*A* and 2-*B*. The translucency of the defect on the lateral surface of the lateral condyle of the femur is not noticeably increased by removing the surrounding soft parts (see arrow). Anteroposterior views did not show the excavation in either case. Our further experiments likewise did not demonstrate pronounced differences between macerated bones and bones enclosed by soft structures in regard to the visibility of defects.

The roentgenographs of Figure 3 illustrate our technic. *A* is the control film showing a macerated femur in anteroposterior and mediallateral view. In *B*, two disk-like cortical defects of a diameter of 0.5 cm. and of a depth of 0.2 cm. have been produced which leave the spongious structure almost untouched. One is located at the lateral surface of the lateral condyle, the other at the posterior surface of the medial condyle. Both are filled with paraffin. *B′* depicts the same defects filled with opaque material. Anteroposterior and lateral films are negative for the lateral excavation; the medial one is faintly visible on lateral view. In *C*, the defects have been enlarged and deepened into the spongious layer. Their base has a diameter of 0.5 cm., their depth is also 0.5 cm. The medial defect is now visible on anteroposterior and lateral view —the lateral still cannot be demonstrated in either view. In *D*, both defects have been enlarged and deepened. Diameter of base and depth of defects is 0.75 cm. The lateral now becomes also faintly visible on lateral view. In *E*, both defects have the following dimensions: diameter of base and depth, 1 cm. The lateral is now also well marked on the lateral view, but negative on anteroposterior view. In *F*, only the lateral defect has been enlarged and filled with opaque material (since the medial was well outlined on previous films). Its base is now 1.3 cm. in diameter, its depth also 1.3 cm. It still does not show up on anteroposterior view. Enlargement of the lateral defect to 2 cm. at the base and to a depth of the same size is necessary to make it distinctly visible

also on anteroposterior view (Figs. 3-*G* and 3-*G'*).[3]

From this experiment we come to a number of essential conclusions. Most important of all is the fact that not all osseous defects are visible on the roentgenograph in either front or profile view, but that they require a certain size in order to appear on the x-ray film. The minimum dimension necessary for visibility varies with the location of the defect. In our case we compared two excavations of identical size, shape, and volume and obtained the following results:

Defect 1 on posterior surface of medial condyle is visible at

0.5 cm. diameter of base, 0.2 cm. depth } on profile view

and

0.5 cm. diameter of base, 0.5 cm. depth } on front view

Defect 2 on lateral surface of lateral condyle is visible at

0.75 cm. diameter of base, 0.75 cm. depth } on profile view

and

1.75 cm. diameter of base, 1.85 cm. depth } on front view[4]

From the direction of the axes of the two defects one would expect Defect 2 to be visible on profile view at about the same size as Defect 1 on front view and, correspondingly, Defect 1 on profile view at about the same size as Defect 2 on front view. This would be true if certain conditions were identical in both cases, *viz.*:

(1) The diameter of transradiated bone which is superimposed over the defects;
(2) The relative amounts of cortex and spongious matter;
(3) The distance of the defects from tube and film.

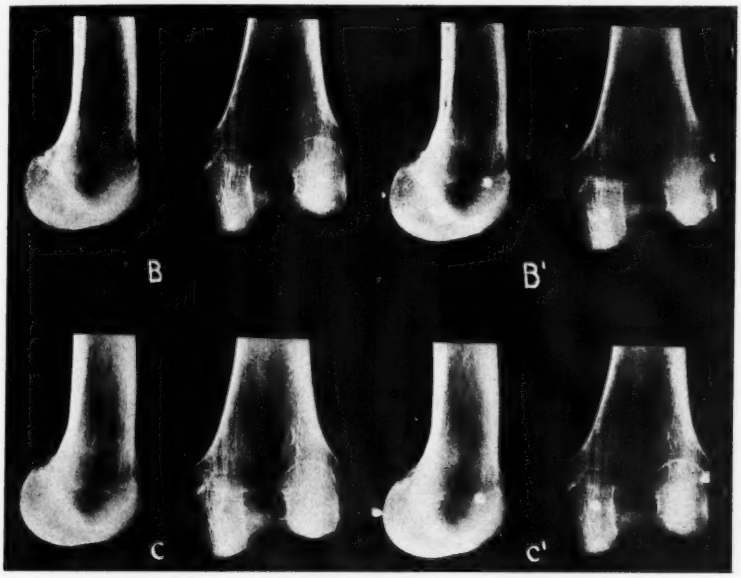
Inspection of the skeleton of the distal end of the femur convinces us that this is not the case. The knee joint especially is characterized by very irregular arrangement of its parts and by very unequal distribution of cortex and spongious bone, as we have shown in a previous paper. Closer study of the site of our defects and the reasons for their different degrees of visibility enables us to realize that one excavation is located on the most posterior part of the median condyle, a portion which is not superimposed over the lateral condyle in profile view, while Defect 2 is situated in an area which in this view is overlaid completely by the other condyle. Figures 3-*E* and 3-*E'* demonstrate the importance of this superimposition. While on lateral view, part of Defect 1 in the posterior portion of the medial condyle is superimposed over the other condyle and is obscured by it, the more posterior area of the defect is distinctly visible (see arrow). Thus while *a priori* the direction of the axis of Defect 2 is more favorable in lateral view, the configuration of the bone cancels this advantage. One more important reason for the different degrees of visibility of the two defects in the medial and lateral condyle lies in the normally greater translucency of the medial condyle in anteroposterior view, the reason for which we have given in a previous paper.

Many of the problems touched upon in the experiment just described need further discussion and experimental clarification. We were especially interested in the question of the visibility of defects in relation to their size. Excavations of conoid shape involving only the spongious structure require a diameter of from 0.5 to 1.75 cm. at their circular base and a depth of from 0.5 to 1.9 cm., depending on the site and the bone involved. Figure 4-*A* shows, beside the barium-filled defect in the posterior part of the lateral condyle and another in the intercondyloid area which originated from previous experiments, a faint hazy translucency in the suprametaphyseal area on the anteroposterior view. The lateral view is almost negative for this defect. Figure 4-*B* shows the same defect filled with

[3] A number of intervening roentgenographs with defects of gradually increasing size are not shown here.

[4] At this size the defect was barely visible in the roentgenograph.

barium and demonstrates the large dimensions of this excavation. The diameter at the base is 1.75 cm., the depth 1.9 cm. In contradistinction to this defect, the well marked excavation in the intercondyloid area, which measures 1.25 cm. at its base and has a depth of 1.3 cm., already showed up on anteroposterior view with a diameter of 1 cm. at the base and with a depth of 1 cm.



Figs. 3-*B* and 3-*C*. Roentgenographs of the same femur as in the control Figure 3-*A*. Medial condyle to the left, lateral to the right in anteroposterior view. In *B*, two disk-shaped cortical defects of a diameter of 0.5 cm. and a depth of 0.2 cm. have been produced. One is located at the lateral surface of the lateral condyle, the other at the posterior surface of the medial condyle. Both are filled with paraffin. *B'* depicts the same defects filled with opaque material. Anteroposterior and lateral films are negative for the lateral excavation; the medial one is faintly visible on lateral view. In *C*, the defects have been enlarged and deepened into the spongious layer; their base has a diameter of 0.5 cm., their depth is also 0.5 cm. The medial defect is now visible on anteroposterior and lateral views. The lateral cannot be demonstrated in either view. *C'* shows defects filled with opaque material.

Figures 5-*A* and 5-*B* demonstrate two defects in the proximal end of the tibia of a knee joint with all its soft parts attached.

The excavations are located in the spongious structure of the medial condyle posteriorly and of the lateral condyle anteriorly, and measure 0.8 cm. at their base, their depth being 1.1 cm.[5] Our figure shows the lateral defect rather indistinctly on the anteroposterior view; the medial defect is shown more clearly. Both defects are almost invisible on the lateral view. Defects of smaller dimensions did not show up at all. After the excavations had been enlarged to 1 cm. at the base their visibility became better on the anteroposterior view, but was still limited on the lateral view.

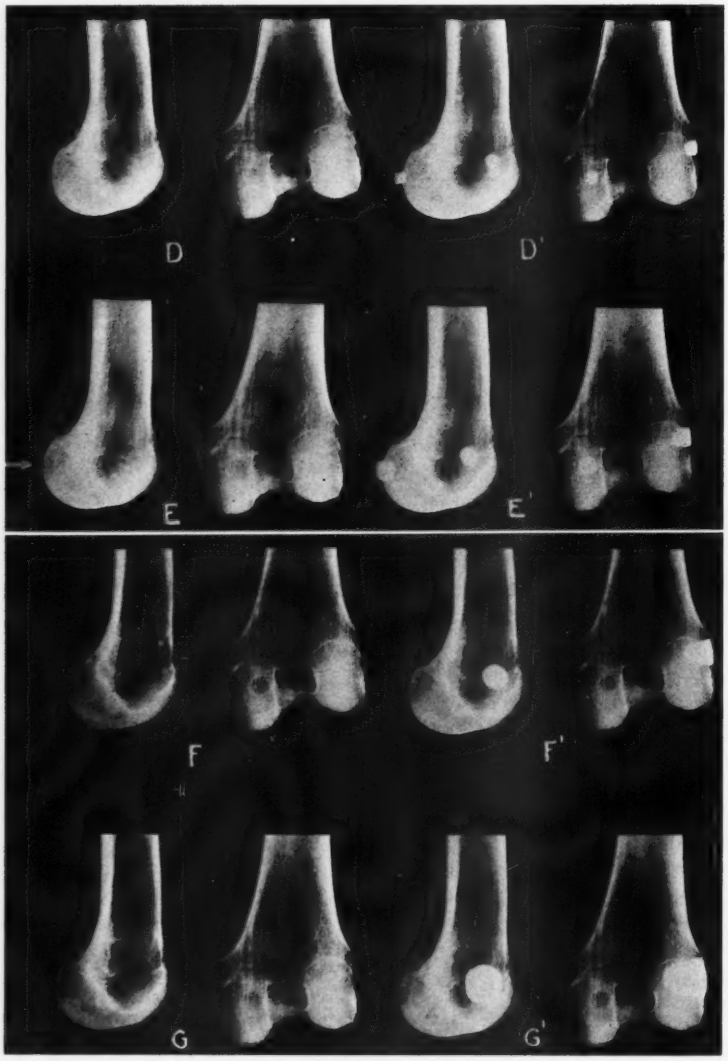
Our experiments showed that change in position of the objects so that the defects were situated close to the film did not markedly improve their visibility.

In one group of experiments we compared identical defects in two bones of different thickness. The defects were so arranged that they had the same size and position and their base was the same distance from the film. As was expected, the result showed that the defect in the

[5] Defects in the spongious structure of the femur condyles originated from previous experiments.

thinner bone was visible to a greater degree.

The following experiment was undertaken to illustrate the influence of osteo-

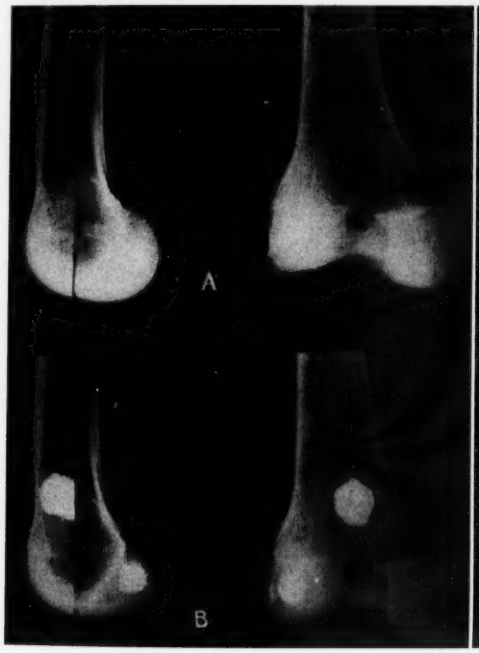


Figs. 3-*D* and 3-*E*. Roentgenographs of the same femur as in the control Figure 3-*A*. Medial condyle to the left, lateral to the right in anteroposterior view. In *D*, both defects have been enlarged and deepened. Diameter of base and depth of defects is 0.75 cm. The lateral is also faintly visible on lateral view. In *E*, both defects have the following dimensions: diamete of base and depth 1 cm. The lateral is also well marked on lateral view, but negative on anteroposterior view. Arrow in *E* points to the defect in medial condyle which is partly obscured by the other condyle, but well shown in its posterior portion. *D'* and *E'* depict the defects filled with opaque material.

Figs. 3-*F* and 3-*G*. Roentgenographs of the same femur as in the control Figure 3-*A*. Medial condyle to the left, lateral to the right in anteroposterior view. In *F*, only the lateral defect has been enlarged: its base is 1.3 cm. in diameter, its depth also 1.3 cm. It still does not show up on an eroposterior view. *G* shows enlargement of the lateral defect to 2 cm. at the base and to a depth of 2 cm. Defect is now distinctly visible in both views. In *F'* and *G'* only the lateral defect is filled with opaque material..

porosis of the surrounding bony structures on the visibility of a destruction in the spongious matter. The distal end of a macerated femur was divided in a sagittal plane into lateral and medial portions, then the medial portion was again divided in a frontal plane into anterior and posterior parts. A defect was produced in the cancellous tissue of the posterior portion of the medial condyle. It measured 0.7 cm. at the base and had a depth of 0.8 cm. The part overlying the destruction was then decalcified by chemical means. The portion containing the defect was not treated. Roentgenographs were taken at each stage. Figure 6-*A* is the control roentgenograph; Figure 6-*B* shows the bone after it was split, with the defect in the posterior portion of the medial condyle. The destruction is almost invisible. Figure 6-*C* depicts the same bone after the overlying portion had been decalcified. The defect can now easily be demonstrated. The arrangement shows the importance of a surrounding osteoporosis for the visibility of destructive processes. Given the same size of a focus it will be much more visible if accompanied by osteoporosis, as is frequently the case in tuberculosis, in contradistinction to a focus surrounded by undecalcified bone as in osteomyelitis or syphilis.

A large group of our experiments comprised cortical defects. Disk-like cortical excavations were produced, filled with paraffin and a paraffin-barium mixture,



Figs. 4-*A*—4-*B*.

Figs. 5-*A*— 5-*B*.

Fig. 4-*A*. Shows, beside the barium-filled defect in the posterior part of the lateral condyle and another in the intercondyloid area which originated from previous experiments, a faint hazy translucency in the suprametaphyseal area on the anteroposterior view. The lateral view is almost negative for this defect.

Fig. 4-*B*. Shows the same defect filled with barium and demonstrates the large dimensions of this excavation. The diameter at the base is 1.75 cm., the depth 1.9 cm.

Fig. 5-*A*. Demonstrates two defects in the proximal end of the tibia of a knee joint with all of its soft parts attached. The excavations are located in the spongious structure of the medial condyle posteriorly and of the lateral condyle anteriorly, and measure 0.8 cm. at their base, their depth being 1.1 cm. Defects in the spongious structure of the femur condyles originated from previous experiments. The figure shows the lateral defect rather indistinctly on the anteroposterior view; the medial defect is shown more clearly. Both defects are almost invisible on lateral view.

Fig. 5-*B*. Shows the same defects filled with barium.

gradually enlarged and roentgenographed at each stage. The defects were made as superficial as possible so that they would involve mainly the cortical structure and then were deepened into the spongious layer. This changed their shape from flat disks to conoids. Figure 7-*B* depicts three cortical defects on the medial surface of medial condyle and epicondyle. Their diameter at the base is 1 cm., their depth 0.5–0.7 cm. Figure 7-*A* is the control. Barium filling in Figure 7-*C* illustrates the size and positions of the excavations. Even by careful comparison with the control film they are barely to be detected.

Again as in the case of spongious defects our results showed that the size of a defect is less important than its position in relation to the x-ray beam. The diameter by which superficial cortical defects of equal depth could be made out in the roentgenograph varied in our experiments from 0.5 cm. to 2 cm.

Figure 8-*B* demonstrates two defects, 2 cm. in diameter at the base and with a depth of 0.75 cm. Defect 1 is located on the anterior surface of the medial condyle of the tibia, Defect 2 on the posterior surface of the lateral condyle. While the anteroposterior view is negative for Defect 1 and positive for Defect 2, the lateral view is negative for Defect 2 and positive for Defect 1, thus demonstrating the advantages of the combination of the two standard positions. Figure 8-*A* is the control; Figure 8-*C* shows the defects filled with barium. Previous experiments had shown that by reason of the relatively small size of the bones of the knee joint change in the direction of the x-ray beam from lateral-medial and anteroposterior to medial-lateral and postero-anterior did not produce any marked improvement in the visibility of defects.

But often two standard projections are not sufficient to reach optimum results. Destructions in the area of the intercondyloid fossa illustrate this best. Figures 9-*A*–9-*C'* depict a small excavation, 0.5 cm. in diameter at base, 0.4 cm. in depth. Lateral and anteroposterior views are almost negative for this defect, while

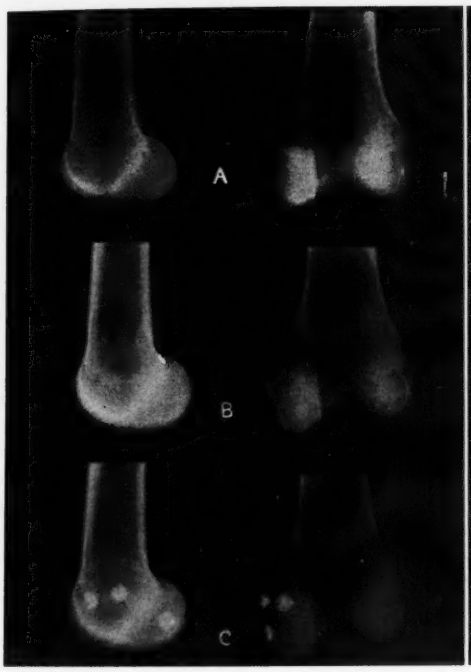
Fig. 6-*A*. Control roentgenograph of the distal end of a normal macerated femur.

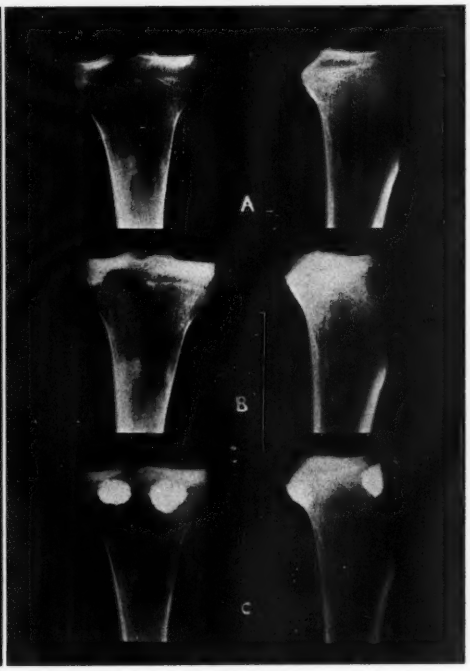
Fig. 6-*B*. The bone has been divided in a sagittal plane into lateral and medial portions, then the medial portion has again been divided in a frontal plane into anterior and posterior parts. A defect has been produced in the cancellous tissue of the posterior portion of the medial condyle. It measures 0.7 cm. at the base and has a depth of 0.8 cm. The destruction is almost invisible.

Fig. 6-*C*. The part overlying the destruction has been decalcified by chemical means. The portion containing the defect has not been treated. The defect can now easily be demonstrated.

it is well shown by a special view which was introduced by Béclère and by Frik and has been described by Kaiser, Danelius and Miller, Hulten, and Holmblad.[6] Analytical study of this new projection shows that it is especially well adapted to demonstrate changes in lateral and medial walls of the intercondyloid fossa, areas which are obscured in the standard projections. The roof of the intercondyloid fossa is best shown on an anteroposterior view.

In a previous analysis of the roentgen anatomy of the knee joint it was pointed out that the distal anterior and posterior contours of Ludloff's spot which are noticeable on lateral view correspond to a narrow cortical zone in a plane laid through the center of the intercondyloid area (Fig. 10). Defects in this zone will show up as interruptions of the contours of Ludloff's spot in lateral view. Figures 11-*A*–11-*C* depict a defect in this area. Its base is 1 cm., its depth 0.5 cm. The defect is noticeable as an interruption of the distal outline of Ludloff's zone in its most anterior part (notice arrow). Even smaller destructions that the one described may be





Figs. 7-*A*—7-*C*. Figs. 8-*A*—8-*C*.

Fig. 7-*A*. Control roentgenograph of the distal end of a normal macerated femur.

Fig. 7-*B*. Depicts three cortical defects on the medial surface of medial condyle and epicondyle. Their diameter at the base is 1 cm., their depth 0.5–0.7 cm. The defects can barely be detected.

Fig. 7-*C*. Demonstrates the defects filled with barium.

Fig. 8-*A*. Control roentgenograph of the proximal end of a macerated tibia. Medial condyle to the right, lateral to the left in anteroposterior view.

Fig. 8-*B*. Demonstrates two defects, 2 cm. in diameter at the base and with a depth of 0.75 cm. Defect 1 is located on the anterior surface of the medial condyle of the tibia; defect 2 on the posterior surface of the lateral condyle. While the anteroposterior view is negative for Defect 1 and positive for Defect 2, the lateral view is negative for Defect 2 and positive for Defect 1, thus demonstrating the advantages of the combination of the two standard positions.

Fig. 8-*C*. Shows the defects filled with barium.

[6] A defect in the metaphyseal area visible on special view originated from previous experiments.

detected in this area. But if the defect is located 1 or 2 cm. to the right or left of the middle line on the same patellar surface of the femur, then this interruption of the contour of Ludloff's zone does not take place.

Rather unfavorable for demonstration are defects on the superior articular surface of the tibia or in the anterior and posterior intercondyloid fossa of the proximal end of the same bone. If they involve only the cortex of this area they are almost always not to be detected, except when interrupting the contours of the roentgenograph. Part of the spongious structure has to be destroyed to make the defects visible. Out of the great number of experiments arranged in the condylar area of the tibia, only one may be shown (Figs. 12-*A*–12-*C*). The defect is located in the posterior intercondylar fossa. It is 1.25 cm. in diameter at the base, 1.3 cm. in depth. Exact comparison with the control (Fig. 12-*A*) shows only slightly increased translucency in the area involved. The experiment also demonstrates the difficulty in detecting destructive foci in regions which are normally more translucent than their surroundings.

As an example of early visibility the following defect may be demonstrated (Figs. 13-*B* and 13-*C*). It is located in the cortex of the anterior surface of the patella. Its diameter at the base is 0.5 cm., its depth 0.3 cm. The excavation is well shown on medial-lateral and postero-anterior views. We found defects of such small dimensions visible also on the femur and tibia, if they were located marginally, *i.e.*, if they led to an interruption of the contours of the roentgenogram. In this respect cortical defects on the lateral surface of the lateral condyle of the femur have a better chance to be visible than those on the medial surface of the medial condyle, since the former surface lies nearly in the plane of an anteroposterior x-ray beam, while the latter is oblique to it. Defects on the former will, therefore, more frequently be seen on edge and will produce marginal interruption.[7] Our experimental studies on the intercondylar fossa and in other areas, and the facts just mentioned, have demonstrated that the more views we take of a given bone, beside the two standard projections, the better are the chances to demonstrate destructive lesions. For this reason oblique views which bring other parts of the bone in a marginal position are very helpful and should more often be employed. Generally speaking, the more complicated the outer contour of a bone the greater are the chances to overlook destructive foci.

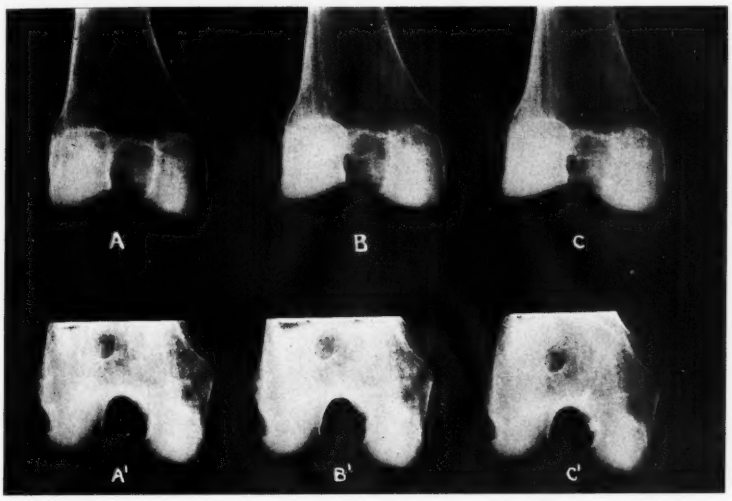
Beside the position of the defect in relation to the central ray, the other factors determining its visibility are the amount of cortical and spongious tissue overlying it in the x-ray view and the relative share each of these two structural components has in the production of the roentgenogram, as discussed in a previous publication. It is also one more reason to take x-ray films from different angles, so as to vary the diameter and character of the superimposed structures.

Of further importance is the character of the border of a destructive focus. If clear-cut and well defined, the chances of its being visible are greater than if hazy and indistinct. The contents of the destructive focus also play a rôle. All our defects were filled with paraffin, which has approximately the same absorption coefficient for x-rays as granulation tissue. If bone débris fill the defect, as frequently is the case in destructive foci, then the chances of its visibility are impaired. Our experiments demonstrated that an excavation becomes less readily visible if filled with a mixture of paraffin and bone dust than with paraffin alone.

It seems a worthwhile undertaking to examine the x-ray symptomatology of destructive processes of the knee joint in the light of our experiments. From the

[7] The defect on the lateral surface of the lateral condyle, shown in Figure 3, was too far anterior to be marginal on the anteroposterior view. It is the area around the popliteal groove and the lateral epicondyle which is responsible for the roentgenographic contour in this region.

large group of different lesions, tuberculosis, osteogenic sarcoma, and osteochondritis dissecans shall be selected. This promises to give us a better insight into the limitations of our method; especially for the early lesions, than comparison of roentgenograms and autopsic material, which is otherwise so valuable.



Figs. 9-*A* and 9-*A'*. The control roentgenographs of the distal end of a macerated femur in anteroposterior and special view. A defect in the metaphyseal area visible on special view originated from previous experiments.

Figs. 9-*B* and 9-*B'*. A small excavation 0.5 cm. in diameter at base, 0.4 cm. in depth. The anteroposterior view is almost negative for this defect while it is well shown on special view.

Figs. 9-*C* and 9-*C'*. The defect filled with barium.

TUBERCULOSIS

The following authors have concerned themselves with a correlation of pathologic and roentgenologic findings in tuberculous joints: Franz Koenig, Ely, Fraser, Woldenberg, Lovett and Wolbach, Phemister, Ghormley, Fritz Koenig, Pitzen, Greig, Girdlestone, Sorrel and Sorrel-Dejerine, Ghormley, Kirklin and Brav, Phemister and Hatcher, Hellner, and Lange. Their studies are based mainly on advanced cases of bone tuberculosis and their opinions differ as to the diagnostic value of the x-ray method as an aid in the early diagnosis and differential diagnosis of tuberculosis. Extremely optimistic statements on the value of the roentgenogram, such as Fraser's (who identified each of the pathologic varieties of joint tuberculosis on the roentgenogram), can be contrasted with others pointing out that "there may be extensive bony involvement by tuberculosis without any appreciable change in the x-ray picture" (Ghormley), or that "there exists no roentgen picture that is entirely typical of joint tuberculosis in any of its stages" (Sundt). On the whole the skeptics predominate. Fritz Koenig states that one cannot practise pathologic anatomy with the roentgen plate and cannot obtain from it complete information on pathologic changes in the same way as is offered on the operating or autopsy table. As an example of over-estimation of the possibilities of the roentgenogram, the following sentences from Fraser's book on "Tuberculosis of the Bones and Joints in Children" may be quoted:

"The original marrow tubercle appears in the negative as a rounded light point. The

cellular collection which constitutes the tubercle offers an increased resistance to the passage of the rays, with the result that the negative demonstrates its presence as a point of diminished density. . . . Normally, marrow appears in the negative as a dark structureless background, from which the clearer lamellæ stand out. For some distance around a tuberculous focus one finds that the marrow loses its dark homogeneous character and becomes lighter with a faint striated appearance. The skiagraphic impressions are concomitant with a histological marrow fibrosis."

Fig. 10. Roentgenograph of three sagittal sections of macerated femur, put together, two adjacent ones representing two peripheral sections from medial condyle and a third of about 7 mm. thickness corresponding to the center of the intracondyloid area. Slices are arranged according to their natural position in the complete bone. Distal contour of Ludloff's spot is visible.

Max Lange points out that the roentgenogram fails frequently in the early diagnosis of tuberculous joint disease, while Pomeranz believes that joint tuberculosis can be recognized by roentgenologists fairly early.

It is the purpose of this paper to attempt to throw some new light on the problem of the limitations of the roentgenogram in knee joint tuberculosis. Based on the above described experiments and on clinical experiences, we will attempt to answer the following questions in regard to tuberculosis of the knee joint which are bound up in the problem of the diagnostic limitations of the method: Does every instance of tuberculosis of the knee joint produce changes in the roentgenogram? In other words, is it possible to exclude tuberculosis from a negative x-ray film? Does the roentgenogram give a true picture of the stage and progress of the disease, and can we arrive at a correct evaluation of the prognosis from its study? Finally, do other diseases have the same manifestations on the film as tuberculosis?

In connection with these questions the roentgen symptomatology of the tuberculous knee joint will be discussed under the following headings: (1) changes in the soft tissues; (2) alteration in the width of the joint space; (3) bone atrophy; (4) bone destruction; (5) sequestration.

Soft tissue swelling is one of the first clinical signs of knee joint tuberculosis. It is an expression of a synovitis which leads to thickening of the capsule and of an inflammation of the peri-articular structures. Roentgenologically, it requires special exposures to demonstrate the soft structures sufficiently. According to Ghormley, Kirklin, and Brav, diagnosis of synovial thickening by the x-ray alone may offer many difficulties, although this sign was present in three out of five of their early cases. It will be easier to demonstrate synovial and peri-articular swelling by clinical examination. Beside, it is in no way pathognomonic and may be seen in other inflammatory processes of the joint.

Changes in the width of the roentgenologic joint space will express themselves as widening or narrowing of the joint fissure. It is surprising how great is the number of early cases of knee joint tuberculosis in which there is no alteration in the width of the joint space (Schinz). In previously described experiments on unembalmed fresh cadavers we tried to determine the amount of fluid necessary to produce a raising of the patella from its bed on the femur. If we measured the distance between certain points on the patella and femur which can easily be identified, we found that an injection of 20 c.c. increases the distance between these given points by 0.2 cm.; of 40 c.c. by 0.3 cm.; 60 c.c. by 0.5 cm. This could be demonstrated only by very exact comparison with the healthy knee, a comparison which would be rendered impossible by swelling of the peri-articular structures on the diseased side. According to Borak and Goldhamer, clinical ballottement of the patella can be demonstrated by filling the joint with 40 c.c. of fluid. The roentgenologic sign of clouding of the joint space, which has been described by Pomeranz, will often not be discernible or cannot be differentiated from peri-articular swelling. The latter will lead to an apparent increase in the width of the joint fissure due to an increase in the distance of the object from the film. To understand the limitations of the x-ray sign of widening of the joint space produced by an intra-articular exudate we have to keep in mind that the exudate will first fill all the recessus of the joint cavity before it will bring about a separation of the articulating bones. The non-specificity of a roentgenologically demonstrated exudate will be discussed later.

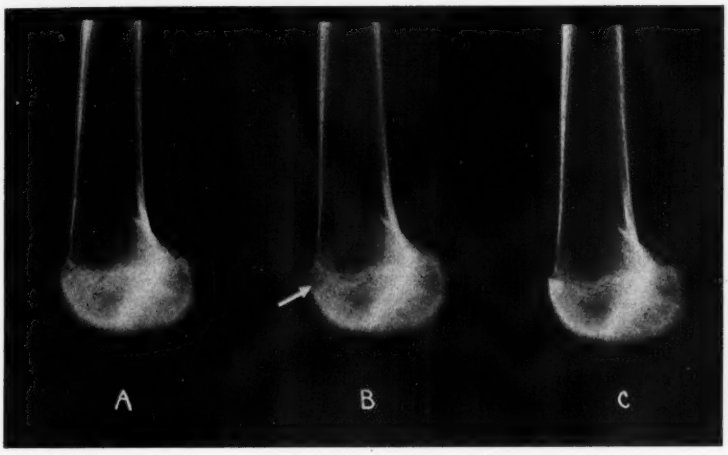


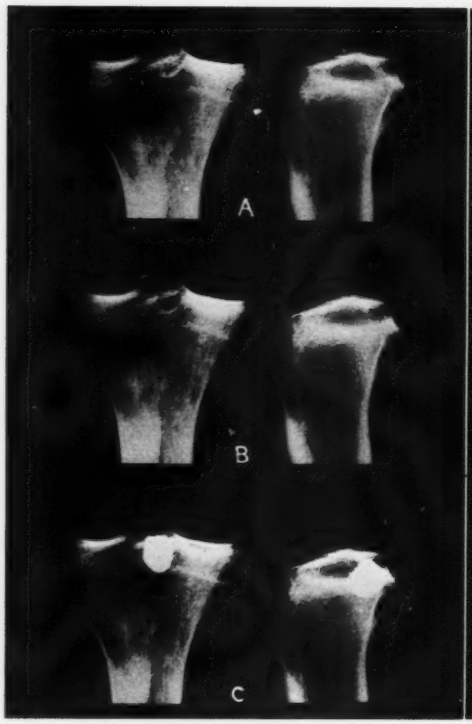
Fig. 11-*A*. Control film of the distal end of a macerated femur.
Fig. 11-*B*. A defect as an interruption of the distal contour of Ludloff's zone in its most anterior part (see arrow). The base of the defect is 1 cm., its depth 0.5 cm.
Fig. 11-*C*. Demonstrates the defect filled with barium.

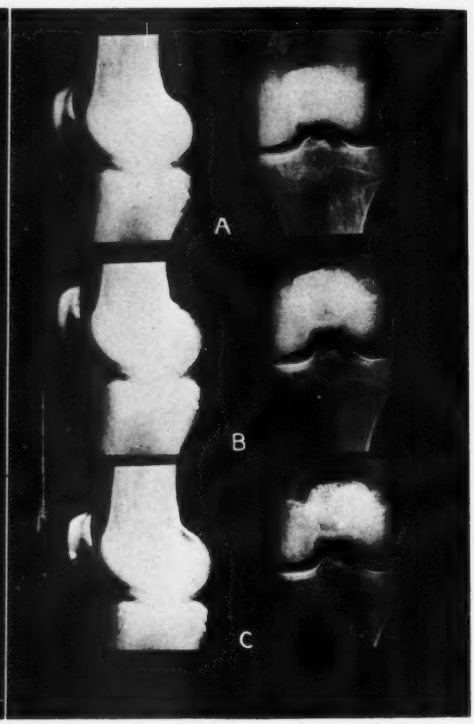
Narrowing of the joint fissure is a sign of destruction of the cartilage. According to Schinz, the width of the so-called joint space in the roentgenogram of the knee joint varies normally from 4 to 8 mm., so that small narrowing of the fissure due to destruction of cartilage may still be within the normal limits. Ghormley, Kirklin, and Brav call attention to the fact that changes in the position of the knee may cause modification of the roentgenographic appearance of the intra-articular area. The greater the flexion, the narrower will

be the representation of the joint space on the film, regardless of the amount of cartilage remaining. The joint fissure is also at least 1.5 mm. narrower in the upright than in the horizontal position (Popovic and Doric). Control films of the normal side should always be taken with the knee in the same position as that on the diseased side. Narrowing of the joint fissure is not an early sign of knee joint tuberculosis (Phemister, and Phemister and Hatcher). According to these authors, the loosened articular cartilages may persist for many months, due to the absence of proteolytic ferments in the tuberculous exudate and to the slow rate of attack and absorption of cartilage by the subchondral granulations after the cartilage has been detached.

In regard to all changes in the knee joint which do not involve bone, it is wise to keep in mind that the roentgenogram is a very inaccurate indicator. We have to realize that a knee joint which appears absolutely normal on the film may be filled with numerous granulations which penetrate the cartilage without attacking the bone. Hellner often did not find any signs of involvement of the joint on the roentgenogram, in cases in which the operation showed a partly tuberculous, partly non-specific pannus covering the cartilage.

Bone atrophy is frequently given as one





Figs. 12-*A*—12-C. Figs. 13-*A*—13-*C*.

Fig. 12-*A*. Control film of the proximal end of a macerated tibia.
Fig. 12-*B*. Demonstrates a defect in the posterior intercondylar fossa, 1.25 cm. in diameter at the base, 1.3 cm. in depth. The film shows only slightly increased translucency in the area involved.
Fig. 12-*C*. Shows the defect filled with barium.
Fig. 13-*A*. Control film of a normal knee joint.
Fig. 13-*B*. Demonstrates a defect in the cortex of anterior surface of patella. Its diameter at the base is 0.5 cm., its depth 0.3 cm. The excavation is well shown on medial-lateral and postero-anterior view.
Fig. 13-*C*. Shows the defect filled with barium.

of the characteristic signs of early tuberculosis. Schinz, for instance, points out that secondary osteoporosis is often the only symptom of early tuberculosis: there will be smooth bone structure, normal width of the joint space, and no changes in the contours of the joint combined with marked decalcification. In fact, many authors have found this symptom-complex rather pathognomonic for tuberculosis.

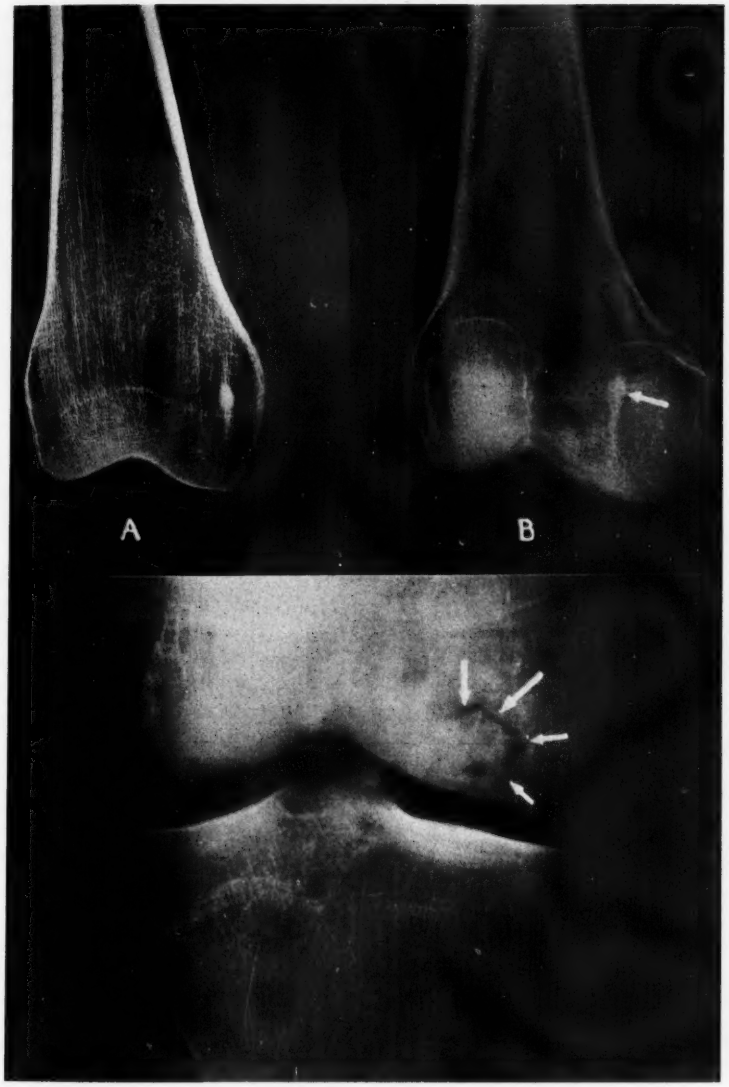


Fig. 14-*A* (*above*). Roentgenogram of a thin section of the distal end of a macerated femur showing a circumscribed area of sclerosis, a compact island.
Fig. 14-*B* (*above*). Roentgenogram of a femur containing the section shown in Figure 14-*A*. The compact island is almost invisible (see arrow).
Fig. 15 (*below*). Roentgenogram of an osteochondritis lesion in a fairly early stage. The necrotic bone fragment is surrounded by a more translucent zone of demarcation (see arrow).

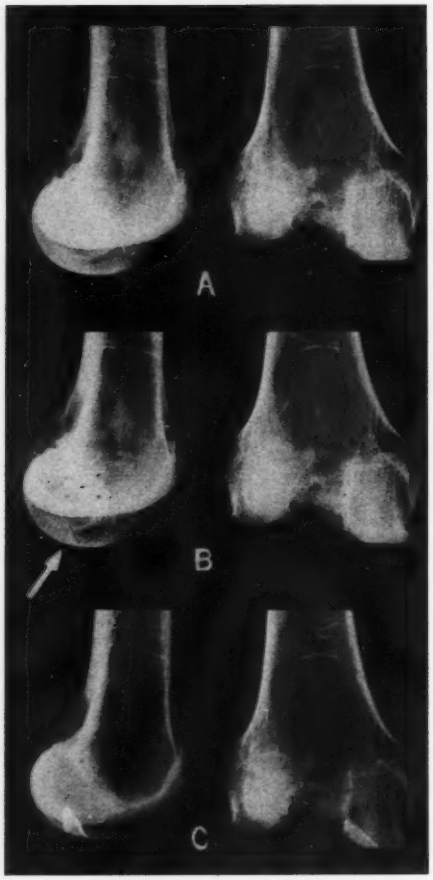


Fig. 16-*A*. Roentgenogram of the distal end of a macerated femur.

Fig. 16-*B*. A wedge-shaped piece of bone has been cut out from the medial condyle at approximately the typical position, replaced and roentgenographed. The anteroposterior view is negative; the lateral shows the demarcation barely outlined (see arrow).

Fig. 16-*C*. The gap surrounding the fragment has been filled with barium so that the defect and the fragment are well outlined.

And yet we know of numerous cases of tuberculosis of the knee joint in which osteoporosis was not present in early *stages*. (Schiller and Altschul, Pomeranz). Hellner states very truly that atrophy in itself is a roentgen sign which speaks neither for nor against tuberculosis.

In a previous paper (Lachmann and Whelan) it was demonstrated by decalcification experiments on bones that there are marked limitations to the x-ray diagnosis of osteoporosis. Only under very favorable circumstances can decalcification below 20 per cent be diagnosed. In most bones the calcium loss, in order to be visible, must be in the vicinity of from 20 to 40 per cent. Furthermore, it was shown by these experiments that the amount of decalcification necessary for diagnosis varies considerably in different bones and in different parts of the same bone. While the bones forming the knee joint, due to their structural composition, are rather favorable for demonstration of bone atrophy, it seems doubtful whether a decalcification of less than 20 per cent of the total calcium present would show up on the film. In the light of the above mentioned experiments, any statements which describe bone atrophy as starting in a certain area and spreading in a certain direction are on weak ground if they are based on x-ray studies only.[8] The value of established osteoporosis for the diagnosis of joint tuberculosis will be discussed later, together with the differential diagnosis.

Bone destruction is, of course, the most important sign of a knee joint tuberculosis. In the material of Ghormley, Kirklin, and Brav, 86.1 per cent of the roentgenograms of verified cases of tuberculosis of the knee joint disclosed definite destruction of bone. It is here that the experiments which have been described above will be most helpful in determining the limitations of the x-ray method.

The position of the primary osseous focus varies. According to pathologic studies (Konschegg), it may be located either in the epiphysis itself, more or less distant from the joint cartilage, or in the metaphysis reaching into the diaphysis. It is supposed to be more frequent in the distal epiphysis of the femur than in the proximal end of the tibia (Pouzet), and

[8] For instance, the following statement by Pomeranz: "In the knee this process [osteoporosis] occurs most commonly in the femoral epiphysis, particularly externally and posteriorly, whereas the tibial condyles, while they take part in the disease, appear to be affected later in the process."

may also occur in the patella (Blumensaat). The pathologists differentiate two types with transitions (Konschegg, Randerath, Max Lange). The first type, the granulating (fungous) tuberculosis is characterized by the formation of granulations which produce early destruction of bone trabeculæ and thus lead to formation of a bone cavity which is filled with tuberculous granulations or necrotic débris. The second type, the caseous form, leads to early necrosis of bone trabeculæ, but caseation of tuberculous tissue results before the enclosed bone trabeculæ are destroyed (Lange). Within the caseous masses the more or less preserved bone trabeculæ are necrotic, but not altered in their structure (Schinz). A wedge-shaped area of necrosis with the base directed toward the joint or the periphery of the bone may be the expression of this type of a tuberculous lesion. In later stages of the disease both types are often represented, or we find transitional pictures. Secondary involvement of the joint occurs in both forms

Fig. 17. A fragment of bone consisting of cortical and spongious substance has been detached from the medial condyle of one femur of a cadaver and placed in the knee joint of the other in front of the medial condyle. This knee joint is depicted in this figure after it has been opened up and closed with as little damage as possible. The fragment is well outlined on lateral view (see arrow), but is invisible on anteroposterior view.

From this description we realize that the productive granulating type will produce earlier changes in the roentgenogram than the caseous exudative. According to Schinz, it takes about three months or more before a tuberculosis of the skeleton will produce visible changes on the x-ray film. Our experiments show the reason. Destructive foci have to reach a certain size before they are visible, the dimensions varying with the location of the focus and the relation of its longest axis to the direction of the x-ray beam. It may be recapitulated that conoid-shaped spongious defects must be 0.5 to 1.75 cm.

in diameter at their base and 0.5 to 1.9 cm. in depth to be visible, and that disk-like cortical defects must have a diameter of from 0.5 to 2 cm. in order to be seen. While very small cortical defects can be detected if they are encountered tangentially by the x-ray beam, cortical destruction in an unfavorable location will show up only if it also involves underlying spongious layers. Defects on the articular surface of the tibia were especially hard to show, while excavations on the lateral and medial wall of the intercondyloid fossa of the femur were easily depicted on special projection. It was further demonstrated that defects of the same size and position have a different degree of visibility, depending on the thickness of the bone involved. Thus destructions in children's bones will, other things being equal, show up earlier. The character of the border of the focus also plays an important rôle. Clear-cut or slightly sclerotic margins will facilitate visibility, while ill defined contours may obscure a defect.

Our experiments proved that general osteoporosis overlying a bone cavity makes for better visibility of the lesion. On the other hand, accompanying demineralization may make an area of destruction appear larger than it actually is. "Decalcified bone adjacent to an infective focus may appear to be destroyed. In tuberculous disease, the area of destruction is much less than the area of decalcification" (Watson-Jones and Roberts). Sometimes it may be difficult to make out focal destruction in a normally more translucent area, like Ludloff's spot, or the medial condyle of the femur (Lachmann).

From the facts presented it becomes clear that x-ray studies will not furnish sufficient information in classifying knee joint tuberculosis in primary osseous and synovial forms. Bony foci, from which the tuberculosis of the joint originally started, may not show up on the film, so that the disease is falsely regarded as purely synovial (Hellner, Phemister and Hatcher, Fritz Koenig). Likewise, in advanced cases in which signs of synovial involvement are combined with bone destruction, it will be impossible to define the starting point of the affection.

The synovial type of joint tuberculosis will naturally lead much later to roentgenologic manifestations of bone involvement. According to Schinz' experiences, a supposedly primary synovial form may show an osseous focus at the earliest after seven months, but sometimes only after three years. Smith gives 32 months as the average time before joint tuberculosis has been suspected. Beside the above mentioned narrowing of the joint space, as an expression of the destruction of cartilage, tuberculous gonitis will, in its later stage, lead to irregular, fringed contours of the adjacent bones and to marginal erosions. But as Fritz Koenig has pointed out, the tuberculosis of the capsule must be rather far advanced before it produces such changes in the roentgenogram. Hellner describes a case of tuberculosis of the knee joint of eight years' duration with negative x-ray findings. The autopsy demonstrated a fungus of the capsule. Granulations had partly overgrown the cartilage. The normally irregular contours of the femoral epiphysis in early childhood (Ludloff) and of the bony patellar nucleus (Köhler), as well as the rough outline of the planum popliteum in advanced age should not be misinterpreted as a sign of bone involvement in a suspected case of gonitis.

Patellar tuberculosis is not so rare as might be expected. Franz Koenig found in 281 cases of osseous tuberculous gonitis an isolated focus in the patella 33 times, *i.e.*, in 11.3 per cent. Köhler gives the relative frequency of incidence of tuberculosis in patella, femur, and tibia according to numerous statistics as 2:5:6, and states that these foci of primary tuberculosis of the patella can scarcely ever be seen in early stages in the roentgenogram. Kolodny lists from his own studies in children the following proportions: 7:59:34. The characteristic signs of patellar involvement are, beside the atypical general atrophy of the bone, a

focus of destruction (Kopstein, Blumensaat). Köhler mentions cases without any atrophy with quite definite and sharply delimited translucent foci. This is the type we tried to imitate with our experiments (Figs. 1-*A* and 1-*B*). Spongious defects were visible when they reached a diameter of from 0.5 to 0.75 cm. at the base and a depth of from 0.5 to 0.75 cm. Cortical defects of 0.5 cm. in diameter and 0.3 cm. in depth could also be demonstrated. Attention should be called to a normally more translucent area at the apex of the bone, which is frequently also the site of early tuberculosis (Franz Koenig).

It has been pointed out above that, especially in the caseous type, we may encounter large foci of necrotic bone which cannot be detected as such on the roentgenogram. This is the case if the decalcified ring of demarcation is so narrow that it cannot be made visible (Schinz, Pomeranz), or if the sequestrum is formed after considerable atrophy has taken place (Phemister). In this event there will not be any noticeable difference in the density of the vital and necrotic bone. Ghormley, Kirklin, and Brav, who tested the accuracy of the roentgen method in showing up sequestra, compared the films and gross specimens of cases of tuberculosis of the knee joint which definitely showed bony sequestra. In 35 per cent the roentgenogram demonstrated the lesion present, but in 65 per cent it failed to show the exact condition although in some cases with more than one sequestrum the error was only partial.

While cyst-like tuberculous bone cavities, as they have been described in detail by Kienböck, and in the American literature by Elliott, can usually be detected on the film, they may escape detection, as our experiments show, if they are small or unfavorably located, especially if they are filled with bone débris. Wells and Long, in "The Chemistry of Tuberculosis," point out that calcified necrotic masses in tuberculosis resemble bone ash in their proportions of calcium and magnesium phosphate and carbonate. Greig described minute spicules of the fragments of trabeculæ which escape decalcification and can be found as fine, gritty particles in the caseous masses. This we tried to imitate in our experiments by filling the excavations with a mixture of paraffin and bone dust. The result was that the defects became less visible if they contained bone detritus than if they were filled with paraffin alone.

Model experiments on cadavers as well as clinical experience has taught us that all x-ray signs which have been given as characteristic for early tuberculous lesions have their pronounced limitations.[9] It has become especially clear that a negative roentgenogram does not exclude the possibility of tuberculosis of the joint.

Given these limitations, the x-ray method is, compared with other diagnostic procedures, still one of the best means to follow the course of the disease and to demonstrate its advance, standstill, or cure. But here also we have to make certain reservations. Attention has been already drawn to the fact that the roentgenogram does not allow any reliable conclusions as to the starting point of the disease; it has further been pointed out that, in the presence of a bony focus, negative findings in the joint itself do not establish the synovial cavity as free from involvement (Girdlestone), and *vice versa*. These facts thus limit the possibilities of arriving at a correct prognosis from the x-ray film alone. While atrophy in itself is a fairly reliable sign of activity of a process, lack of atrophy in presence of bone destruction does not prove healing (Hellner). Other limitations can be derived from the fact that not every sequestrum can be seen in the roentgenogram and that reactive processes as osteosclerosis and periostitis, are not necessarily expressions of a superimposed streptococcic or staphylococcic infection (Reinberg, Lovett and Wolbach, Pitzen, Pomeranz). Pitzen describes a tuberculous focus of the planum popliteum with marked periosteal reaction.

[9] Rarer signs, *i.e.*, productive processes and deformities, have been excluded from this discussion.

This leads us to the last point of this discussion: Are the classic roentgenographic signs of knee joint tuberculosis pathognomonic for this disease? From clinical experience this question can be answered in the negative. Smith reports 63 cases of chronic joint disease suspected of being tuberculosis, which came to operation, and in 39.7 per cent of these tuberculosis was not present (quoted from Elliott). Sundt found that in 61 cases operated on for probable tuberculosis of the knee joint, 48.4 per cent were non-tuberculous. While the diagnosis in these cases was based on all evidence at hand, we may assume that the roentgenogram played an important part. It is, of course, not one x-ray finding in itself, but a combination of signs which is supposed to establish the roentgen diagnosis of knee-joint tuberculosis. Rarely will the whole group of so-called classic signs be present, and combinations of x-ray symptoms in cases of tuberculous gonitis can be matched by x-ray findings which prove to be non-tuberculous.

A frequent roentgen finding which is often a diagnostic puzzle is marked atrophy of all bones forming the joint, combined with signs of an exudate and thickening of the capsule. The atrophy is either patchy and the bone texture blurred or diffuse and homogeneous and the individual trabeculæ well defined, depending on the acuteness of the pathologic process. Neither one of these findings is pathognomonic for tuberculosis. Friedrich, Burckhardt, Lotsch, Sundt, and Hellner have concerned themselves with a study of these cases and call attention to the frequent occurrence of a chronic unspecific synovitis, "pseudotuberculosis" (Friedrich). According to these authors, the chronic hydrops genu offers one of the most difficult diagnostic problems. Friedrich believes that the possibilities of the roentgenogram in the diagnosis of these joint lesions are highly overestimated. Burckhardt gives the relation of frequency of incidence of non-tuberculous to tuberculous synovitis as 50:50 (quoted from Hellner). Marked decalcification is not always present in tuberculosis and both types of osteoporosis can be found also in non-specific gonitis (Friedrich). Sundt points out that even under bioptic control it is often impossible to differentiate the unspecific from the tuberculous process with the naked eye. All types of non-tuberculous infections including syphilitic (Sundt) and gonorrheal (Kisch), as well as subacute and chronic post-traumatic hydrops (Breitlaender), may imitate very closely the roentgenogram of tuberculous synovitis.

If the destruction of the joint progresses and leads to necrosis of cartilage, the resulting narrowing of the joint space is in no way typical of tuberculosis. On comparing the roentgenograms of the tuberculous and non-tuberculous cases, Ghormley, Kirklin, and Brav found that as a rule in non-tuberculous cases there was more rapid and extensive narrowing of the joint space for a given duration of disease. Certain definite exceptions, however, were noted, so that this form of differentiation was by no means conclusive. The same authors likewise point out that the site of the greatest destruction can in no way be used as a differentiating feature, as was shown by their comparative studies on autopsy material and roentgenograms.

Another differential diagnostic problem is a fairly round destructive focus in the spongious matter of the distal end of the femur or the head of the tibia with or without slight sclerosis around the cavity and with or without periosteal reaction. The bone in the neighborhood does not show any atrophy. Kienböck has given an extensive description of these lesions in tuberculosis and has called them *Epiphysenfugencysten.*" They are, on the whole, rather benign and produce only mild clinical symptoms, but may perforate into the joint (Kienböck, Lange). In the American literature, Elliott and also Sundt have described similar cyst-like lesions of tuberculous origin in the knee joint which appeared under the picture of ostitis fibrosa cystica. With Holmes and Ruggles

and others, we must say that there is nothing in the manifestations of these lesions to distinguish them from any low grade infection. Bland osteomyelitis under the picture of Brodie's abscess (Reinberg, Sorrel and Sorrel-Dejerine), as well as syphilis in its different forms must be taken into account. Parasitic (Kienböck) and traumatic cysts and primary and secondary tumors may produce similar pictures.

Summarizing our findings in this respect we can say that the following statement by Sundt is amply supported by clinical facts: "There exists no roentgen picture that is entirely typical of joint tuberculosis in any of its stages."

OSTEOGENIC SARCOMA

The bones forming the knee joint constitute one of the favored sites of osteogenic sarcoma. According to Kolodny, 72 per cent of all cases of osteogenic sarcoma are found in the lower extremity, 82 per cent of which affect the region about the knee, *i.e.*, femur or tibia. The femur and tibia have the highest frequency of involvement (more than 70 per cent of all cases). The site of predilection in both bones is the metaphysis adjacent to the knee joint (Kolodny).

In discussing the roentgen diagnosis of osteogenic sarcoma of the knee joint and its limitations, we have to ask ourselves: Can this affection be present with negative roentgen findings? Does the roentgenograph give us a true picture of the extent, character, and progress of the lesion? Are the roentgen signs of osteogenic sarcoma characteristic for this affection?

Since the x-ray film furnishes the surgeon with the main indication for surgical interference, it will very rarely be possible to contrast positive autopsic findings with a negative roentgenogram. But from the study of the course of typical, later autopsically controlled, osteogenic sarcomas we know that there is frequently a first stage with clinical symptoms while the roentgenogram does not reveal any pathology. If we try to express our conceptions of the early pathology of osteogenic sarcoma in terms of roentgenographic manifestations we realize that there will be a stage in every sarcoma that will necessarily escape roentgen diagnosis. A very instructive case of a fibrosarcoma of the lower end of the femur which showed no roentgenographic changes three months after onset of clinical symptoms but depicted marked signs of bone destruction and bone proliferation eight months later, is shown by Hodges, Phemister, and Brunschwig in Ross Golden's "Diagnostic Roentgenology."

Our above described experiments imitating destructive lesions as well as clinical experiences have demonstrated that foci may far exceed microscopic dimensions before they become possible of detection on the film. Our experiments have furthermore shown that visibility of destructive foci will depend not only on their size but also on their location in cortical or spongious bone, their relation to the central x-ray beam, the character of their margin, whether clear-cut or ill defined, sclerotic, decalcified or of normal density, on the density of the tumor itself which produces the osseous defect, and on the calcium content of the bone in the neighborhood. Since the destructive focus produced by the malignant tumor is usually not sharply delimited, the figures for earliest visibility established by our experiments are probably too low for the sarcomatous type of destruction. In all these considerations one should not forget, as Schinz has pointed out, that the parenchyma of the tumor, as long as it is not calcified or ossified, casts a shadow having the density only of soft structures and is, therefore, not directly visible.

Not accessible to our experimental approach, but also of great importance for early diagnosis are proliferative and reactive processes. But since the early changes of osteogenic sarcoma are frequently those of bone destruction only, we cannot expect the reactive processes in all cases to be present from the beginning.

But even in cases in which there is early

proliferative reaction leading to osteosclerosis, this may escape the roentgen diagnosis. While we did not have any means to imitate osteosclerosis artificially, chance helped us. In Figure 14-*A* we see a thin section of the distal end of the femur showing a circumscribed area of sclerosis, a so-called compact island. In the roentgenogram of the femur containing this section (Fig. 14-*B*) the compact island was barely recognizable. By analogy we are justified in assuming that if osteosclerosis is not very extensive, it may escape detection on the roentgenogram. Clinical experiences mentioned by Hertzler point in the same direction. He found that in cutting into an early periosteal tumor spicules of bone may be perceptible that did not show in the x-ray film. If bone sclerosis is visible it will frequently not be possible to distinguish roentgenologically between bone produced by the tumor itself and non-tumorous reactive ossification.

Practical experience in osteosarcoma has taught us to realize that the tumor is usually larger than the x-ray film shows. "The tumor is in advance of the bone changes which can be indicated radiographically" (Brailsford). Hertzler calls attention to the fact that the surgeon by gentle manipulations may cause fracture in cases in which the x-ray did not show such an extensive bone destruction. Kolodny lays great emphasis on the fact that tumors which appear roentgenographically to be entirely periosteal may involve the medullary cavity and *vice versa*. He has seen cases in which the medullary cavity was literally stuffed with tumor from end to end, while the roentgenograph indicates a tumor wholly limited to the area of involvement of the cortex and periosteal reaction. "The shaft of a bone surrounded by an osteogenic sarcoma and appearing normal in the roentgenogram is not to be considered free of involvement; a tumor may show up well around a bone, which casts a normal appearing shadow despite an extensive involvement of the haversian system and medullary cavity" (Kolodny).[10] The application of these experiences for the surgeon in selecting the site of amputations in osteosarcoma is evident. For the same reasons it will be impossible to base classification of osteogenic sarcoma in periosteal and medullary types on x-ray evidence alone (Kolodny). Kolodny also stresses the fact that the greatest care should be exercised in the prognostic evaluation of the roentgenologic evidence. The statement that the bone-forming type has a better prognosis than the osteolytic may lead to many disappointing fallacies.

In discussing the roentgenologic differential diagnosis of osteogenic sarcoma of the knee region we must realize that there is no individual sign which is absolutely pathognomonic for this affection. Inflammatory processes and secondary malignancies may sometimes offer one or the other of these manifestations, which commonly have been regarded as typical for osteogenic sarcoma. Experienced observers of the roentgenologic semiology of sarcoma have stressed this fact (Codman, Geschickter and Copeland, Kolodny, Putti, Schinz). "A bone reacts against a tumor in the same way that it does to destructive stimuli which are non-neoplastic" (Putti). The two most characteristic x-ray signs of osteogenic sarcoma, the triangular lipping of the periosteum and the formation of radiating bone spicules, can be observed also in chronic infections of the bone, in metastasis, and subperiosteal hemorrhages. They are an expression of an unspecific reaction of the periosteum. The sun-ray arrangement of the newly formed bone was found in only 18 per cent of the cases of osteogenic sarcoma of the Registry material (Kolodny). The periosteal reactions of chronic osteomyelitis and of bone syphilis, together with the accompanying bone destruction, may easily be mistaken for neoplastic changes. Trau-

[10] On the other hand, the accompanying bone atrophy may obscure the extent of the tumor in the opposite sense. In osteolytic sarcoma the tumor may be less extensive than the x-ray suggests (Watson-Jones and Roberts).

matic myositis ossificans may closely imitate osteogenic sarcoma (Coley). In Singleton's group of primary malignant tumors the confusion of inflammatory lesions with newgrowth was responsible for about 50 per cent of the erroneous roentgenologic diagnoses. In infective arthritis of the knee joint the accompanying bone atrophy may imitate the irregular bone destruction of osteogenic sarcoma, and in the early stages the differentiation is often difficult (Singleton). Summarizing our brief differential diagnostic discussions, we may state that while the roentgen method is still best to demonstrate the pathology of osteogenic sarcoma without surgical interference, it is unable to furnish us with findings which are absolutely pathognomonic for osteogenic sarcoma.

OSTEOCHONDRITIS DISSECANS

In a last group of experiments the roentgen symptomatology of osteochondritis dissecans of the knee joint was approached. The lesion has its favored site on the lateral aspect of the medial condyle of the femur in close proximity to the insertion of the posterior cruciate ligament (Mueller, Walter). Without going into the details of the etiology and pathology which are still a matter of dispute, it is worthwhile for the understanding of the x-ray pathology to take notice of different stages of the disease corresponding to the extent of the lesion and the degree of sequestration of the fragment (Conway). With Köhler, we may assume that the disease is probably, at first, latent for years without causing any clinical symptoms. The pathologic finding in this stage would be a circumscribed bony necrosis, perhaps larger than the future sequestrum (Axhausen). The necrosis of the osseous tissue could be demonstrated only microscopically; roentgenologic as well as gross anatomical study of the bone would lead to negative results. At a later phase the necrotic fragment would be separated from its surroundings by a layer of fibrous tissue and fibrocartilage, while the articular cartilage covering it remains intact with the rest of the cartilaginous surface of the joint (Köhler, Axhausen). It is this stage which produces the first roentgen symptoms and with which we are concerned in our experiments. Figure 15 shows the roentgenogram of an actual osteochondritic lesion of this type. While the necrotic bone fragment appears only slightly more dense than its environment, it is essentially the more translucent zone of demarcation which makes the necrotic focus recognizable. Thus we realize that it depends mainly on the width and the position of this radiotranslucent ring whether the affection will be visible at this stage or not.

Again we attempted to approach this problem by model experiments imitating the affection as closely as possible. Figure 16 demonstrates the result. *A* is the roentgenogram of the macerated bone which is otherwise untreated. In *B*, a wedge-shaped piece of bone has been cut out from the medial condyle at approximately the typical position, replaced, and roentgenographed. The anteroposterior view is negative; the lateral shows the demarcation barely outlined. In *C*, the gap surrounding the fragment has been filled with barium so that the defect and the fragment are now well outlined. This experiment was repeated several times on different femora with the same result. When the line of demarcation, which always corresponded to the thickness of the saw blade, did not exceed one millimeter, the front view was always negative and the side view gave only a faint and interrupted outline of parts of the fissure surrounding the fragment. From these experiments we come to the conclusion that there are limitations to the roentgen diagnosis of osteochondritis dissecans at this phase of the lesion. The possibilities of showing the zone of separation at this stage roentgenologically are further limited by the fact that it may be filled with bony débris (Axhausen) which would obscure the fissure.

As the resorption of osseous tissue progresses the line of demarcation widens and will now make its appearance on the x-ray

film. It is wise to use stereoscopic and special views as recommended by Hodges, Phemister, and Brunschwig. Occasionally the dissected fragment consists only of cartilage, perhaps with a small attached bony lamella. In this case it cannot be detected by x-rays (Schinz). In advanced stages the fragment is displaced from its bed and may lie anywhere in the joint cavity. Schinz calls attention to the fact that it is sometimes not possible to detect the site on the femur from which the fragment originated. In order to find fragments which have been separated from their bed, as many views as possible should be used. That even large osseous loose bodies may escape visualization in one projection is shown in Figure 17. Here a fragment of bone of the usual size consisting of cortical and spongious substance was detached from the medial condyle of one femur of a cadaver and placed in the knee joint of the other side, which had been opened up and closed with as little damage as possible. Then x-rays in the two standard positions were taken. While the fragment is well outlined on lateral view it is invisible on anteroposterior view.

The roentgenogram of later stages of osteochondritis dissecans is usually typical, but the author recalls a case in which all the x-ray signs pointed to the diagnosis of osteochondritis and yet biopsy proved it to be tuberculosis. Ghormley reports a similar case. Thus even in a disease the diagnosis of which seems to be within the exclusive domain of the roentgenologist, we arrive at the conclusion that there are stages which may escape x-ray visualization and that other affections may simulate its x-ray signs.

SUMMARY

1. Based on a previously published analysis of the roentgenogram of the normal knee joint, an experimental approach to its roentgen pathology is presented.

2. More than 190 defects of varying size and location have been produced in all bones forming the knee joint. They involve cortex and spongious layer separately and combined. Comparison with the roentgenograms of the untreated control and with the films showing the defects filled with opaque material affords an opportunity to recognize the faintest signs of destruction and to mark out the limitations of roentgenologic procedure.

3. Our results show that not all osseous defects are visible on the roentgenogram in either frontal or profile view, but that they require a certain size in order to appear on the x-ray film. The minimum dimension necessary for visibility varies with the location of the defect. Conoid-shaped excavations involving only the spongious structure require a diameter of from 0.5 to 1.75 cm. at their base and a depth of from 0.5 to 1.9 cm. Disk-like cortical defects must have a diameter of from 0.5 to 2 cm. in order to be seen. The paper lists examples of locations especially favorable or unfavorable for visibility of destructive foci and points out the importance of different projections for their demonstrability.

4. Factors determining visibility of a defect are: (*a*) direction of its longest axis in relation to the central x-ray beam; (*b*) diameter of transradiated bone which is superimposed over the defect; (*c*) relative amounts of cortical and spongious matter in the overlying bone; (*d*) distance of the defect from tube and film; (*e*) character of border of excavation; (*f*) content of defect; (*g*) state of calcification of the surrounding bone.

5. In the light of the results of our experiments and based on clinical experiences, the limitations of the roentgen diagnosis in three affections frequently involving the knee joint are pointed out.

6. In this connection the following x-ray signs of tuberculosis of the knee joint are evaluated: (*a*) changes in the soft tissues; (*b*) alteration in the width of the joint space; (*c*) bone atrophy; (*d*) bone destruction; (*e*) sequestration. Special attention is called to the fact that a negative roentgenogram does not exclude the

possibility of tuberculosis of the joint, that the roentgenogram gives us a true picture of the stage, progress and prognosis of the disease only under certain reservations and that none of the classical radiographic signs of tuberculosis in themselves are typical for this affection. One or more of these signs may frequently also be found in non-tuberculous lesions.

7. In regard to the roentgen diagnosis of osteogenic sarcoma of the knee joint it is pointed out that this affection may be present with negative roentgen findings; that the roentgenograph does not give us an absolutely true picture of the extent, character, and progress of the lesion, and that no roentgen sign of osteogenic sarcoma is absolutely characteristic for this affection. The example of a compact island which is well defined on a film of a thin section but barely visible on the roentgenogram of the complete femur, enables us to recognize the limitations of the x-ray method in demonstrating productive processes.

8. The first stage of osteochondritis dissecans will escape roentgen diagnosis. Model experiments imitating later phases of the disease showed that visibility depends mainly on the width and position of the radiotranslucent ring around the necrotic bone fragment. When the line of demarcation did not exceed one millimeter the front view was always negative and the side view gave only a faint and interrupted outline of parts of the fissure surrounding the fragment. Clinical experience teaches us that even in this disease, whose roentgenogram seems so typical, there are no absolutely pathognomonic x-ray signs. Other affections may in rare cases simulate its x-ray signs.

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REMARKS ON CHAOUL TUBE THERAPY[1]

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THE Department of Radiation Therapy at the General Hospital, Birmingham, has now completed two years' work with the x-ray tube associated with the name of Professor Chaoul, of Berlin (1). This period is, of course, too short for the presentation of figures on which you will be able to assess the permanent value and scope of any addition to the methods of treating malignant disease; nevertheless, some facts have been observed which already seem to be of value, and which I hope will serve to stimulate further research in this development of radiation therapy. The tube itself and the principles underlying its application have now been dealt with in considerable detail by various authorities. In British literature, Woodburn Morison and Mayneord (2) first drew attention to the method, which was discussed further and in considerable detail by Chaoul, Woodburn Morison, and myself at a meeting of the Radiological Section of the Royal Society of Medicine of London (3), in 1936. On the purely physical side, mention must be made of Mayneord's (4) invaluable paper, which should be read in detail by all those interested in this branch of radiation therapy, since a proper application of the physical factors is particularly important. Mayneord points out that the main feature of the complete distributions of the depth dose contours is the rapid drop in depth dose, as the rays enter the phantom. Using a 5 cm. target-skin distance and a circular port 5 cm. in diameter (total filtration equal to 0.2 mm. of nickel[2] and 60 kv.), the intensity measured at 2 cm. depth in the usual phantom of water is only 40 per cent of that incident on the surface, at the center of the beam. For larger fields, greater than, say, 4 cm. in diameter, the peripheral drop also makes it imperative that one use a multiple field technic, but fortunately we have a considerable knowledge of the distribution of radiation around complex radiation sources, developed from radiation treatments (5), and this may be applied to the x-ray problem. He also estimates that the "average wave length" of the beam appears to be approximately 0.3 Å. The half value layer in copper is approximately 0.1 mm., and therefore too small to be determined very accurately. In aluminium, as indicated by the absorption curve, the half value layer is 3.3 mm., which would correspond with a homogeneous radiation of wave length 0.31 Å. I have suggested in previous papers that, though some radiologists might at first compare this quality unfavorably with that of x-rays produced at higher voltages, yet the comparison as regards effective wave length may not under all conditions be a fair one, since at depths of the order at which "deep" treatments are carried out, the effective wave length of a beam produced at (say) 200 kv., through a Thoraeus filter, becomes very much the same as that from a Chaoul tube at the surface. This point is of interest if we assume that shorter wave lengths have in themselves some special value in their action on malignant cells.

Actual details of technic must be dismissed very briefly indeed. We have nearly always used the split dose technic, giving about 400 roentgens per session, up to minimum total doses of 6,000 roentgens for malignant lesions. Occasionally for small basal-cell carcinomas, a

[1] Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13–17, 1937.

[2] For practical purposes the filtration value of nickel is equal to an equivalent thickness of copper.

single dose of 2,000 roentgens has been given with complete success, in the case of patients who lived at a distance and could not attend. On the mucous membranes the reaction which Coutard has called "epithelitis" is attained and heals in about eight weeks.

In a recent paper to the British Association of Radiologists, I stated that in my opinion the term "contact therapy" might be considered preferable to more accurate descriptions, since it conveys vividly the first principle of this form of treatment—that it is suitable only for lesions which can be brought into direct contact with the applicator, either by reason of their situation on a surface or because they have been made accessible by surgery. In cases in which the target-surface distance is so short, accurate positioning of the applicator is absolutely essential, if even dosage is to be attained. I have also indicated four cardinal principles (6) for the satisfactory treatment of malignant disease by radiation, which must be applied and appreciated.

1. Any proposed form of treatment must include elimination of any source of chronic irritation.
2. Special attention to the growing edge of the tumor is essential.
3. Any form of treatment must be adequate. A valuable paper by Halberstaedter and Simons (7) brings out this point very well, and incidentally illustrates how woefully often it is not fulfilled.
4. Some method of dealing adequately with the appropriate lymphatic glands must be included, for treatment to be considered really radical.

These four cardinal points should govern the choice and application of any method of treatment of malignant disease. For the Chaoul tube to fulfill Conditions 2 and 3 it will very frequently be necessary to use multiple ports of entry, arranged around the periphery of the tumor, and directed inwards. For Condition 4, I do not in general consider it capable, under clinical conditions, of building up a sufficiently large total dose in the deeper glandular areas. The rapid diminution in intensity of the beam, both in the depths and at the periphery, to which reference has already been made, might at first sight appear to be a serious limitation, but actually it may be an advantage in dealing with certain types of tumors, both malignant and simple. For example, during the last two years, two patients suffering from large fungating epitheliomas on the dorsum of the hand have been successfully treated by the Chaoul tube, with complete healing and minimum disturbance of the extensor tendons. One of these cases may be quoted here in detail to illustrate this point.

E. G., female, married, aged 75 years, was seen on Dec. 9, 1935, complaining of an ulcer on the back of her right hand of four years' duration. Her family had insisted on her coming to the hospital because of the odor from the tumor. A fungating ulcer one and three-quarters by one and one-half inches, on the dorsum of the right hand, was fixed, tender, and very septic, with hard everted edges. No biopsy was made, but clinically the diagnosis of epithelioma could not be in doubt. No grossly enlarged epitrochlear or axillary glands were noted—a not uncommon point in elderly patients suffering from fungating malignant tumors. Chaoul treatment was begun immediately by two circular fields, each 5 cm. in diameter, centered over the upper and lower poles of the growing edge. The target-skin distance was 5 cm., and the other factors were 4 ma. at 60 kv., with a total filtration value of 0.2 mm. copper and an intensity of 80 r per minute. Each field received a total skin dose of 6,000 r, divided over 25 days. A fairly severe reaction followed, somewhat complicated by sepsis, which was treated by an emulsion of acriflavin in liquid paraffin, according to the following prescription:

"Acriflavin"	0.1
Aquae	20.0
Cerae Alb.	4.0
Paraffin Liquid ad	100.0

This patient was seen a month before the date of this report, when the condition was completely healed, and there were no palpably enlarged glands.

The use of multiple small fields concentrated on the growing edge is, on the whole, to be preferred to the use of a single field with the central ray directed through the center of the growth, except in the case of very small tumors such as warts or very early rodent ulcers. If a single field of a larger diameter than 3 cm. is used, my experience is that an adequate dose to the growing edge is possible only at the cost of giving a frank overdose to the center, with a resultant local necrosis, which is tedious in healing and may be quite painful. Adams, in Professor Morison's Clinic at the Cancer Hospital, London, has overcome this difficulty by providing an extra filtration, thicker at the center, and very thin at the edge so as to permit a beam whose maximum intensity is situated at the periphery. On the other hand, it is astonishing what a large total dose can be built up by the use of carefully planned multiple fields, particularly in dealing with exuberant or rather convex tumors, which are not situated too deeply.

The application of the Chaoul tube to lesions which have already received inadequate or unsuccessful radiation treatment is a question which cannot long be avoided, and is indeed to be expected in the practice of any new development in radiation therapy. Chaoul himself has repeatedly stated that lesions which have previously received irradiation by radium or high voltage x-ray are not suitable for treatment by his technic. In general, we have followed this advice, but we make the reservation that every case must be treated on its individual merits, and that the radiation therapist must maintain a certain mobility of attack, ready to adapt his methods in a moment to meet particular circumstances. When after every alternative has been considered, it has been decided to irradiate by means of the Chaoul tube a lesion which has already received unsuccessful treatment, I advise, firstly, a careful survey of the situation, including exact details of treatment and dosage hitherto employed, followed in appropriate cases by the bold administration of a definitely determined dose of at least 6,000 r to the deepest part of the tumor. Anything less is inadequate. I cannot condemn too strongly the exhibition of small "sniping" doses, in the spirit of hopeful expectation that the new form of therapy may in some way prove more specific against malignant cells than one which has included some different wave length or technic, quite regardless of any properly planned total amount of radiation delivered to the tumor. I believe with Ralston Paterson (8) that "the lethal dose for true squamous epithelioma will ultimately be proved to be, for any one fixed over-all time, a remarkably constant figure regardless of where that tumor is situated, and that it probably ranges from 5,000 r in a week to 6,000 or 7,000 r in one or two months, while at the upper end of the scale we find the adenocarcinomas, still very doubtfully curable by external radiation alone, and regarding which we really have the haziest ideas as to the lethal dose." As indicated above, such a total dosage to a previously irradiated area can be given only in special circumstances, and a certain degree of acute necrosis is inevitable and to be expected. Here again the rapid diminution of intensity of the beam, due to the inverse square law and to the low voltage, makes its strict localization quite easy, not only at the sides of the irradiated area, but also in the deeper structures, and this is a most important point in the recovery of the necrosis. Time does not permit a detailed survey of all the criteria by which one would decide on this rather drastic form of treatment. My own feeling is that a consultation with a surgical colleague is often valuable, since some of these cases are undoubtedly best treated by surgery, particularly by diathermy, as advocated by Finzi (9). The great advantage of the Chaoul beam is the possibility of localization mentioned above,

by which any area of actual "overdose" or necrosis can be limited very sharply, so that healing follows in a reasonable length of time. A case history follows.

B. W., female, married, aged 40, was seen in September, 1935, with the following history. A small sore on the left cheek had been present for many years. In 1920 it was treated by "surface radium" (no details available), which failed to cure it, and it continued to "scab over" and occasionally to break down, until the middle of 1934, when it began to grow larger. In January, 1935, the ulcer was one and one-half inches in diameter, and was diagnosed clinically and microscopically as epithelioma supervening on a patch of lupus. It was treated by interstitial radium, and from details available I estimate that a dose of approximately 6,000 roentgens was delivered to the center of the tumor, through 0.5 mm. platinum screening. In spite of this treatment the ulcer did not heal, and though it diminished in area, it continued to penetrate more deeply, and became foully septic. The patient was sent to the X-ray Department in September, 1935, where, after careful consideration, it was decided to attempt Chaoul treatment, as a last alternative to an extensive and rather mutilating operation. A dose of 6,000 roentgens calculated to the floor of the ulcer was given in 15 sessions over 18 days, and then after a short rest of 10 days, a further 1,200 roentgens were given in three sessions—total dose of 7,200 roentgens in 18 sessions over 31 days. The result was a rather severe reaction, which was controlled by daily dressings with acriflavin emulsion. As a result of this heroic treatment, the deeply penetrating ulceration was arrested, and the condition healed steadily, though it was of course necessary to continue daily dressings for many months.

I have quoted an extreme case, but it does illustrate my point that even when, for various reasons, the effect of the Chaoul beam has been to cause necrosis of tissue, the effect is very strictly localized, and the recuperative powers of the immediately adjacent tissues are unaffected. In less serious cases I have sometimes found it advisable and justifiable to allow several weeks to elapse before beginning Chaoul treatment, while the area to be irradiated is carefully cleaned and dressed daily with the flavin or eusol and paraffin. Another case follows.

J. P., male, aged 63, was seen on Oct. 23, 1935, complaining of an ulcer on the back of his neck. It had been treated elsewhere by intermittent doses of x-rays for two years (no definite dosage available). Although no biopsy was taken, the condition was quite obviously an active epithelioma, with typical hard everted edges, and a sloughing base. The patient was kept under careful observation for eight weeks, while he attended for dressings, and treatment by the Chaoul tube was postponed until January, 1936. Two circular fields of 3 cm. diameter, with a 5 cm. target-skin distance were used, and each field was given 4,400 roentgens in 12 sessions over 17 days. The heaped-up edges of the ulcer flattened out rapidly, and became perfectly healthy, but the central part remained as a shallow crater, which took many weeks to heal by granulation, and which was at first very tender and rather painful. To-day the neck looks perfectly healthy, there is a slight feeling of induration on palpation, but no suspicion of delayed necrosis. I cannot help thinking that had a more penetrating radiation been used a much more serious reaction might have been produced.

Another advantage of the strict localization of the Chaoul beam has been found in the treatment of the nodular skin recurrences sometimes seen following radical amputation of the breast for carcinoma. I think most of us now feel that this is a very grave condition, and that frequently, if not almost invariably, it announces the presence of metastasis elsewhere in the body, even though this may not be clinically apparent at the immediate time. In addition to this, we have to consider that any tissue which has suffered an extensive surgical operation is never an ideal

medium for the reception of a heavy dose of irradiation over a wide area. Whatever is the general consensus of opinion on these two points, I think that most radiotherapeutists will agree that a number of cases of skin recurrences following radical amputation are seen every year, the treatment of which by what may be called radical radiotherapy would be of no value in prolonging the life of the patient, and indeed would only cause her unnecessary distress. Such "skin nodules" are controlled with satisfactory ease and certainty by multiple small Chaoul fields, leaving the patient's general condition unimpaired by x-ray dosage including large volumes of tissue, and more able to tolerate heavy doses to visceral or skeletal deposits. Nodules in difficult situations, such as high up toward the axilla or in the anterior axillary wall, can readily be treated by the Chaoul tube. It is surprising how long many of these patients can survive in comfort if a group of skin nodules can be controlled, or a patch of external irradiation healed. A case history in point follows.

A. F., female, married, aged 56, was seen on Nov. 4, 1935, complaining of a fungating ulcer in the middle of an old radical amputation scar in the left chest wall. The amputation had been performed ten years previously, and had never quite healed. Four months previous to the present examination this small unhealed area became sore and began to weep and later to be odorous and to discharge. On examination, the mid-point of the old radical amputation scar in the left chest wall was found to be the site of a carcinomatous ulcer 6 cm. in all diameters, fixed to the lower anterior left ribs and to the left border of the sternum. An enlarged gland was noted in the right axilla (the left had been cleared at operation). Treatment by the Chaoul beam was begun on Nov. 5, 1935. The ulcerated area was divided into five fields: four (peripheral), 5 cm. in diameter; one (central), 3 cm. in diameter. Each peripheral field received 4,800 roentgens over 16 days, in divided doses of 400 roentgens, and the central field 3,000 roentgens over 10 days, with a target-skin distance of 5 cm. The vitality of the tissues involved in the scar was, as one might have expected, not very good, and a severe reaction followed the above dosage. In the light of further experience I now consider that the central field was unnecessary. However, by the end of June (five months later) the whole area had healed, and no clinical evidence of malignancy could be detected. The enlarged gland in the right axilla had by this time become larger, but this disappeared after full doses of high voltage (200 kv.) x-ray filtered through 1.65 mm. copper, by three fields. In November, 1936, a small nodule appeared in the scar region just below the area treated by the Chaoul tube, and this was successfully treated by a further 4,000 roentgens, using a field of very small diameter (1.5 cm., with a target-skin distance of 5 cm.). This patient is still alive and clinically quite well. She has gained weight, and lives a perfectly normal life as a housewife.

Time permits my mentioning only one other point, but it is an important one—the question of co-operation with the surgeon in the treatment of inaccessible tumors, by the Chaoul tube. It is largely with this in mind that I suggested above that the term "contact therapy," although not strictly correct, has a certain value, as it does convey to the surgeon the idea that wide and ready access to deep tumors is desirable, and that the actual applicator at any rate must be brought into contact with the tumor on at least one of its surfaces. For example, in tumors of the tonsil, palate, or alveolus, removal of the teeth is frequently helpful in providing access for an applicator even as large as 5 cm. diameter, and indeed I have stated that, in general, the retention of the teeth in the treatment of malignant disease in the mouth by the Chaoul tube will be possible only in exceptional or very early cases. Again, it will be remembered that our President, in the nineteenth Silvanus Thompson Memorial Lecture, before the

British Institute of Radiology in London last year, referred to the intrathoracic application of x-rays to the stump of a tumor deeply situated in the chest, which might not be completely removable by the surgeon.

Access to rectal tumors may be provided by the Bardenhauer modification of Kraske's approach, involving removal of the sacrum, or by the perineal operation, in which the coccyx is removed. I have mentioned in previous communications a patient who was treated in this way in December, 1935, and since she is still alive and apparently well, I should like to quote her case in some detail, as illustrating, first, the possibilities which the Chaoul tube affords of being worked in a confined and rather difficult space, and, secondly, of how it may be combined with deep x-radiation.

A. E., female, married, aged 56, consulted one of the Honorary Surgeons of the General Hospital in November, 1935, complaining of increasing constipation and diarrhea, and of occasional rectal bleeding and discharge of mucus. Six months previously a very early carcinoma of the rectum had been removed by a local operation, and the continuity of the bowel restored, thus dispensing with the need for a colostomy. On rectal examination, the finger encountered an annular stricture, apparently fibrous, one and one-half inches inside the rectum, beyond which was a soft friable mass, extending chiefly on to the left side. Left iliac colostomy was performed on Nov. 11, 1935, and ten days later the rectum was excised by the perineal route, though with great difficulty. On the left side and rather posteriorly it was impossible to remove the growth completely, and the delivery of the rectum involved cutting through some actual malignant tissue at one point, leaving a considerable residue. The wound was only partially closed, and treatment with the Chaoul tube was begun on Dec. 8, 1935. At each session it was possible to introduce into the wound an applicator giving a target-surface distance of 5 cm., and a circular field of irradiation 5 cm. in diameter. This applicator was passed upward beneath the sacrum and applied to the area of residual growth. A dose of 6,000 r was given in 15 sessions over 17 days, at the end of which time the wound was beginning to close so that the daily introduction of the applicator was becoming rather difficult. A further dose of 1,000 roentgens to the tumor was then delivered externally over five days, by means of a high voltage set (200 kv., filtered through 1.65 mm. copper). This, of course, was easily done, as the skin overlying the tumor was, until that date, quite unaffected by radiation. The tumor area, therefore, received a total dose of 7,000 roentgens, over three weeks. The patient is still alive and in good health, and clinically appears well. A small sinus in the operation area is still discharging but does not cause serious inconvenience. Her gain in weight has been maintained.

I think from the above remarks there can be little doubt that, with the co-operation of the surgeon and increasing boldness of dosage, an increasing sphere of usefulness will be found for the Chaoul tube. I have attempted here to draw attention to some of its less obvious applications—clearly there remain many upon which I have not had time to touch. For example, the basal-cell carcinomas which so often occur in awkward situations, such as the ala of the nose and the canthus of the eye, or epithelioma of the vulva, notoriously difficult to treat by radiation because of the extreme sensitivity of the adjacent skin, can often be treated with advantage by the Chaoul beam.

In conclusion, I should indeed be ungrateful if I neglected to acknowledge the great kindness and help afforded me in Professor Chaoul's clinic at Berlin, and in Professor Woodburn Morison's Department at the Cancer Hospital, London. I should also like to thank the Honorary Radiologists at the General Hospital, Birmingham, for their help and advice, and

Lord Austin of Longbridge, for his generosity in making this research possible.

SUMMARY

1. The Chaoul tube gives a high surface intensity with a comparatively poor depth dose which must be taken into account when planning treatment. In certain situations this may be an advantage.

2. When comparing the effective wave length of the Chaoul beam with that of x-rays produced at higher voltages, allowances must be made for changes in effective wave length of the latter at a depth, due to absorption and scattering (including Compton effect).

3. Application of the Chaoul beam to areas previously irradiated by other methods must be undertaken only after due consideration and preferably after consultation with a surgeon.

4. Every attempt must be made to secure the co-operation of the surgeon in providing access to deep tumors.

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A NEW DEVICE FOR RADIUM APPLICATION IN ESOPHAGEAL MALIGNANCY[1]

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WE have always felt that carcinoma of the esophagus should lend itself to more successful treatment than has been the experience of therapists. This belief is based upon the histologic picture, the absence of early metastases and of extension, and the method of approach in treatment. Squamous-cell epitheliomas, which constitute the most frequent histologic type, have proven relatively amenable to radium in other anatomic sites, and should show equally good results in the esophagus. Carcinoma in the esophagus only rarely yields distant foci of metastases, and usually extends locally, or within reasonable distance of the primary radium beam. The lumen of the esophagus may be considered a readily approachable anatomical site, especially since its passageway has been employed for many years as an entrance to the stomach with numerous appliances. Therefore, a moderately sensitive tumor that remains localized in an approachable site should offer some hopeful aspects in malignancy therapeusis. With these thoughts in mind, we have thrust aside the disparaging reports of the past and tried again, employing a new applicator.

Fundamentally, two basic means of approach to the esophagus have been utilized, the one through the esophagoscope, the second with the aid of gastrostomy. Any device that can obviate the use of either or both methods would indeed be accepted as superior. An operative procedure in older patients who are often weakened and emaciated, presents, in most clinics, a very high operative mortality. Although the use of the esophagoscope offers a ready means for direct examination, biopsy, and insertion of radium, the discomfort and apprehension produced thereby never present any appeal to the patient.

To be sure, radium has been applied locally to esophageal lesions almost from the time of discovery of the new element. Numerous applicators have been devised for tube or seed implantation, and the best proof of their inefficacy has been the refusal of therapists to adopt them.

In 1904 Einhorn (5) presented an interesting device which was constructed from hard rubber and enclosed one radium tube. The short sound was held attached by a silk thread, and application was accomplished by the patient swallowing the thread. Forbes (7) in 1920, Beck (1) in 1921, Pinch (14) in 1922, Mills and Kimbrough (12) in 1920, and Morsh (13) in 1929, respectively, reported the use of various radium containers which were inserted through the esophagoscope.

Case (4) in 1923, Lewis (11) in 1924, Hanford (8) in 1922, and Watson (18) in 1936 advocate, in their respective reports, a preliminary gastrostomy before radium insertion. Modifications consist in swallowing a thread to be used as an anchor line, or subsequent use of the esophagoscope orally or through the gastrostomy opening.

In 1932 Teperson (16) presented a new device for use through an esophagoscope whereby the tumor mass may be well localized and radon seeds implanted directly in the tumor.

Of special interest in this review is the sound constructed by Jentzer (10), in 1922, which embodied some principles which we employ in our device. Essentially, it consisted of the radium cup hooked on to a mandrel, attached to a string, and a probe to yield rigidity to the applicator. After insertion, the probe and mandrel are unhooked, and the capsule, attached to the

[1] Presented before the Fifth International Congress of Radiology, in Chicago, Sept. 13–17, 1937.

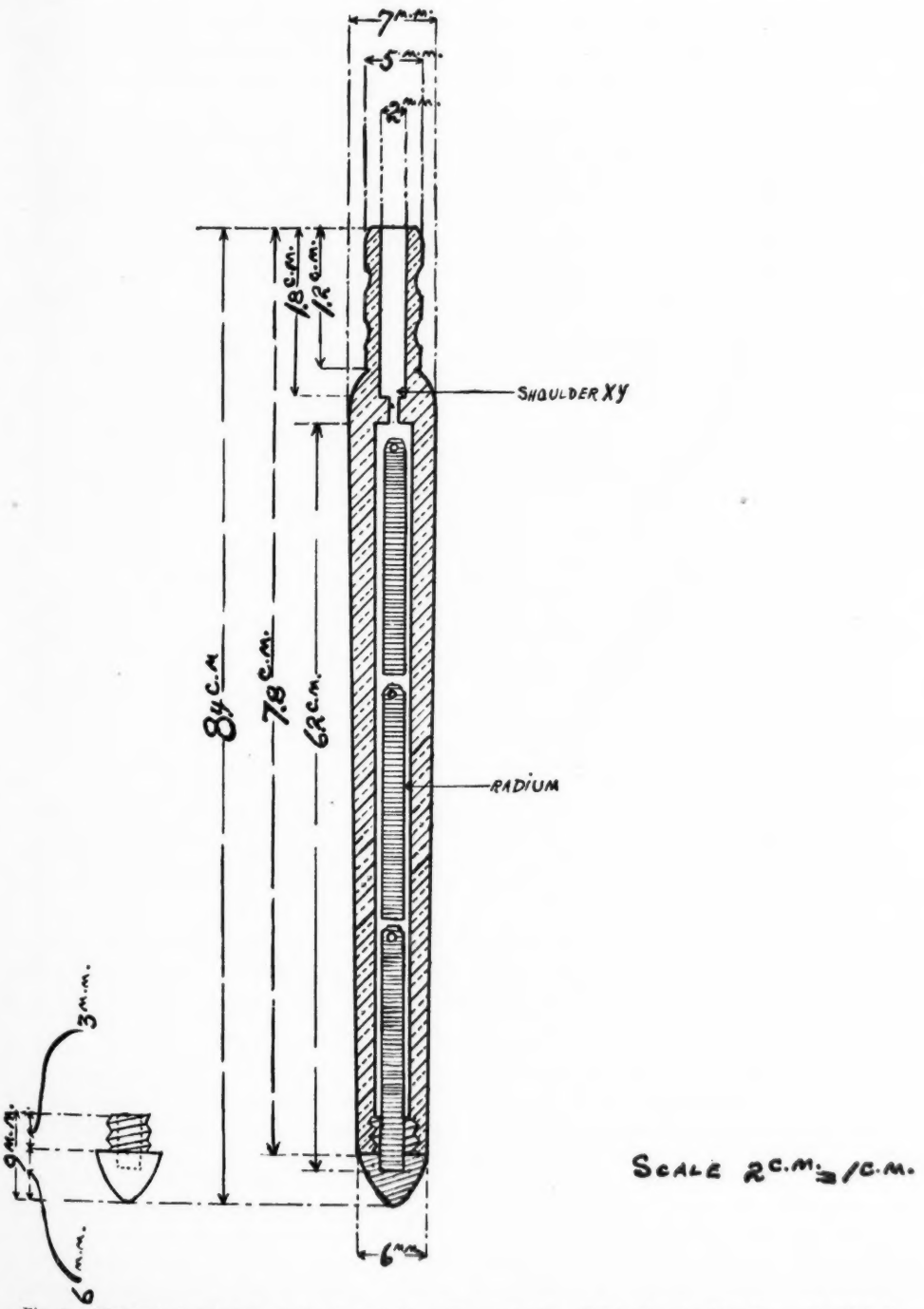


Fig. 1. Mechanical drawing of the three-tube radium capsule. XY is the shoulder through which the fishing cord passes and is held intact by means of a knot tied on the inner end.

string, is allowed to remain in place for the required time. Our observations in connection with the Jentzer applicator are made not so much with a view of criticizing as from the standpoint of drawing attention to some of the salient features of our own device. It is difficult to imagine how the mandrel can force the cup down the esophagus when its contact with the cup is by means of a hook which may cause buckling.

Description of Applicator.—Our applicator consists of four parts: (1) capsule; (2) soft rubber tubing; (3) anchoring cord; (4) stylet and handle. (Fig. 2.)

The capsule, made of hard rubber, measures 8.4 cm. over all with a hollow body 6.2 cm. long, a hollow neck, which is corrugated on the outside, and a screw tip. A shorter capsule capable of holding but two radium tubes measures 6.2 cm. The capsule gradually tapers from an outside diameter of 7 mm. at its widest point to 3 mm. at the end of the blunt nose tip. The diameter of the hollow space is 5 mm. throughout, and the wall thickness is 1 mm. at the thickest point (Figs. 1 and 2).

At the proximal pole of the capsule is a shoulder separating the hollow of the corrugated neck from the hollow body of the

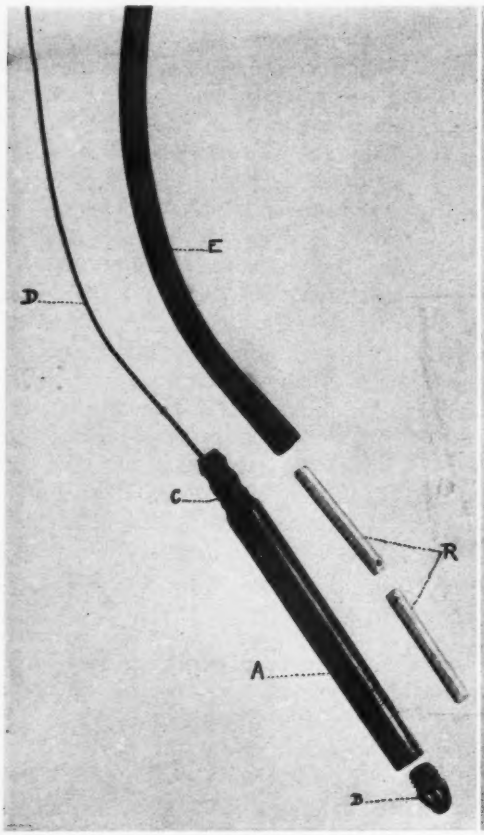


Fig. 2.

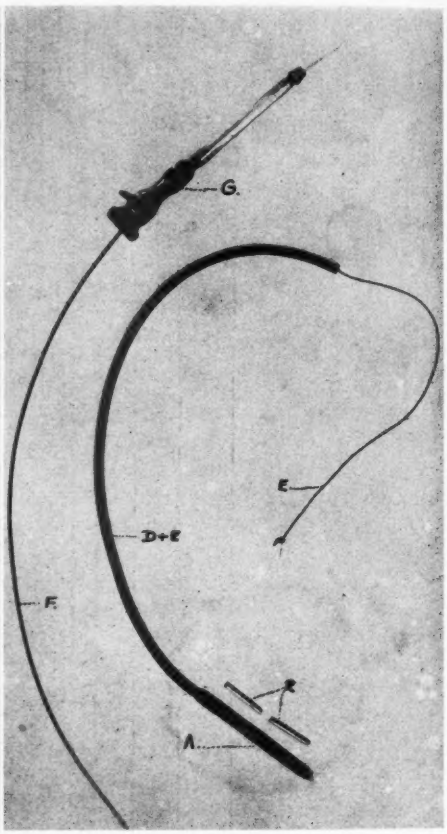


Fig. 3.

Fig. 2. Component parts of the esophageal applicator. *A* is the hard rubber capsule of 6.2 cm. linear measurement, *B* is the blunt screw tip, made hollow to accommodate part of a radium tube, *D* is the fishing line anchoring cord attached to a shoulder in the corrugated neck, *E* is the rubber tubing attached to the outside of the corrugated neck, *R*, radium tubes.

Fig. 3. The assembled sound with wire stylet. *F* is the flexible wire stylet, to which is attached *G*, the handle.

capsule (Fig. 1 -*XY*). This shoulder provides a passageway for the anchoring cord and is the contact point against which the distal end of the stylet lodges. The screw tip is hollow, allowing for part of one radium tube to be contained therein, thereby reducing the over-all length of the capsule.

The rubber tubing is made of latex rubber which gives it elasticity coupled with tensile strength, and, in addition, it imparts to it the quality of becoming smooth and slippery when emersed in water. The tubing—about 35 cm. in length—fits snugly over the corrugated neck of the capsule. This special construction of corrugation affords a very tight hold of the tubing onto the capsule.

The anchoring cord is a thin, linen fishing line (tensile strength of 27 pounds) which is attached to the capsule by means of a knot at one end, then passing through the shoulder from the hollow body to the hollow neck. It continues through the rubber tube and its free end is available for anchorage about the ear.

The stylet has two special features worthy of notice; firstly, the nature of the material, and secondly, the method by which the stylet is shaped. We have chosen No. 27 gauge piano steel wire because it combines flexibility with rigidity, it can be shaped with the hands, straightened out to its original position again, and hold the shape thus given it. This quality is increased by shaping the stylet into a square-shanked proximal end, and a tapered distal end. The square shank affords good contact for the jaw of the handle.

The handle is in the nature of a pin vise, with the square-shanked end of the stylet being firmly gripped in its jaws by a thumb screw. With this, easier and more delicate manipulation of the sound is obtained.

Technic of Application.—The diagnosis, to our minds, is satisfactorily established by roentgen-ray study alone. An irregular filling defect in a patient, often a male, of the cancer age with some symptoms of dysphagia, should warrant the diagnosis. The upper and lower levels of the irregularity as seen in the roentgenogram are indicated topographically, corresponding to the nearest bony structure, as the clavicle or anterior rib margin, and those are marked on the chest by means of ink or a skin pencil. This is done to indicate on the exterior the levels of the lesion for proper placement of the capsule.

Preparation of the patient includes abstinence from food for four hours previous to radium insertion, and morphine and atropine given in adequate doses. The nasopharynx is cocainized to only a moderate extent, enough to lose the pharyngeal reflex, but not to include the larynx or upper trachea.

The instrument is prepared by placing two or three radium tubes into the hollow capsule, and screwing the blunt tip on tightly. The wire stylet is lubricated with jelly, thrust through the rubber tubing, and made to lodge upon the shoulder in the capsule (Fig. 4).

With the patient sitting upright and the head completely extended, the tongue is flattened with a depressor, and the capsule, slightly lubricated with jelly, introduced as far back as the posterior pharyngeal wall. Holding the rubber tubing and stylet about five inches from the terminal sound with one hand, the other hand is placed on the handle, with the anchoring cord wound around the fingers. It is essential to keep the cord taut, thereby assuring constant contact of the distal end of the stylet with the shoulder. Curve the stylet to an arc of about 60 degrees. In this fashion, the inserting tip and a length of six inches is actually a slight arc. The patient is then asked to swallow, and during the act of deglutition, the first gentle thrust is made and the esophagus entered. Pressure is brought to bear very gently, and the sound will proceed downward until the tumor mass is reached. Here, the sensation of the mass is easily transmitted to the fingers because there is a continuous flow of force from the tip of the sound through the stylet, through the handle, and to the fingers. Slow manipulation is made in all directions, maintaining almost a straight

line with the distal end of the sound, until the constricted lumen is found and passed. The moment the lesion is passed the sensation of all resistance disappears. It is essential to reach a level below the lesion. When one has felt that the sound is well inserted, the long wire stylet is slowly, and with slight rotary motion, withdrawn; the rubber tube and anchoring cord will remain in place.

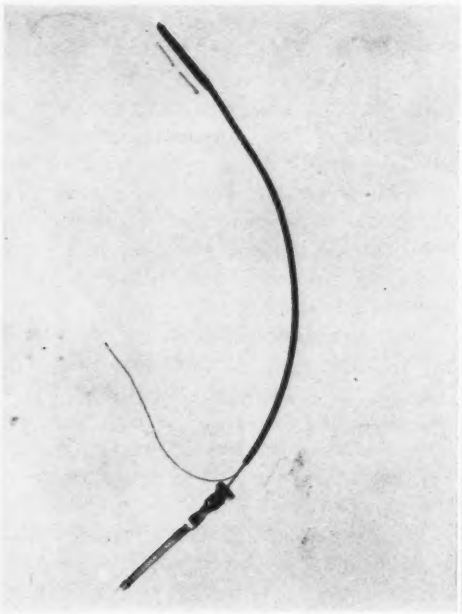


Fig. 4.

Fig. 5.

Fig. 4. The completely assembled applicator with two radium tubes on the side. After insertion, the handle and wire stylet are slowly withdrawn, leaving the capsule, anchoring cord, and rubber tubing in place.
Fig. 5. Several dilators of various sizes along with the regular capsules. The wire stylet is similarly employed here to exert gentle pressure into the lumen of the esophagus.

The patient is then fluoroscoped. With the skin markings previously described upon the chest wall as a guide, the capsule, by means of the cord, is slowly drawn upward to the level. Another method is to measure on the x-ray film the level of the irregularity and to pull the sound up to that definite level while under the fluoroscope. The anchoring cord is wound about the ear, and adhesive employed to seal it securely.

Emphasis is placed upon the suggestion to refrain from giving barium soon after insertion to recheck the level of the sound in the lesion. Principally because the pharyngeal reflex has been depressed by cocaine, and any attempts at swallowing may allow some barium to enter the trachea, producing violent coughing spells—enough to dislodge the sound. If one desires a recheck, it may be done later when the cocaine effect has entirely disappeared.

During insertion great care and gentleness must be exercised. Forceful pressure should not be employed because, if it is indicated, the presumption is that the distal tip of the sound is up against a pocket of the tumor mass, and damage may ensue. Although perforation is always an imminent danger, we feel that the tip of the sound is constructed so bluntly, that perforation appears as a remote possibility. Moreover, by lateral manipulation, drawing upward, and gentle thrust, the lumen

should be found, and the rest of the passage accomplished without difficulty. Manipulation must be by gentle but firm movements. Until the wire stylet is withdrawn the patient may experience tension about the trachea and bronchi to produce some cough. This is suddenly relieved when the stylet is removed. The latter step should be performed slowly and with rotary movements.

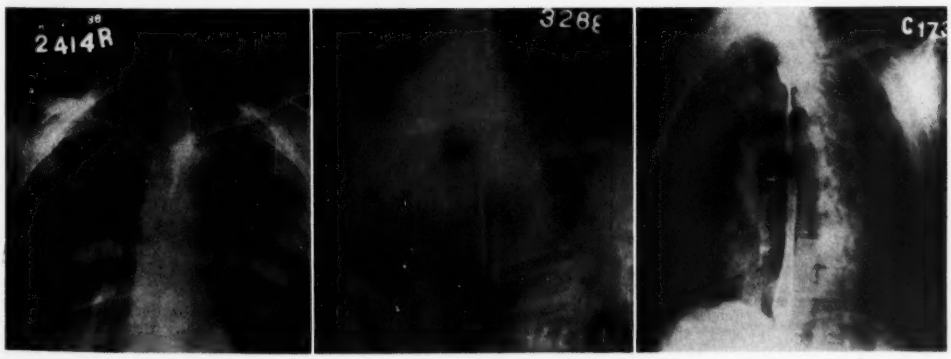
If the insertion does not appear satisfactory, or if the probing stylet is once partially withdrawn, attempts at insertion should not be made without withdrawing the sound completely. This is important because of the mechanics of the applicator, for it is essential that the distal end of the stylet remain constantly on the shoulder of the capsule (Fig. 1), thereby assuring a continuous flow of force. If the stylet has been withdrawn from the neck, pressure may push the distal end through the thin rubber tubing against the walls of the esophagus. Indeed, that is a dangerous procedure.

Instances will be presented in which the radium-containing capsule will not pass the obstructed area with ease. Rather than forceful pressure, we have devised several small dilators made of the same hard rubber, but of slightly smaller diameter, and of lesser linear measurement. Manipulation with the smaller dilators is much easier. The irregularly constricted lumen can thus be slowly dilated until the larger capsule will pass with relative facility (Fig. 5).

These small dilators are inserted with the same technic as previously outlined, and with the application of the same principles. We do not advocate the gradual dilatation of the lumen in every case, because frequently the prepared, loaded radium capsule will find simple passage. Only when the sound cannot be passed should the dilators be employed.

To date, the dose we have employed has been two or three tubes of radium, of 10 mgm. each, filtered through 1 mm. of platinum. The thickness of the sound is 1 mm. of hard rubber, enough to absorb all characteristic secondary rays. The sound is permitted to remain *in situ* for from 24 to 48 hours in the first application, to yield a dose of from 480 to 1,440 mgm.-hours. A second application is made within several days, and if the condition of the patient is good, insertions are repeated at three-day intervals until a dose of from 4,000 to 5,000 mgm.-hr. is given.

During the interval when the radium is in place, olive oil, one ounce three times daily, sodium bicarbonate, and sedatives are given. Liquids such as milk, eggnogs, and whiskey are fed; and if the state of emaciation is pronounced, clysis and intravenous infusions are indicated. The degree of discomfort felt by the patient is, as a rule, negligible, and morphine is seldom necessary.

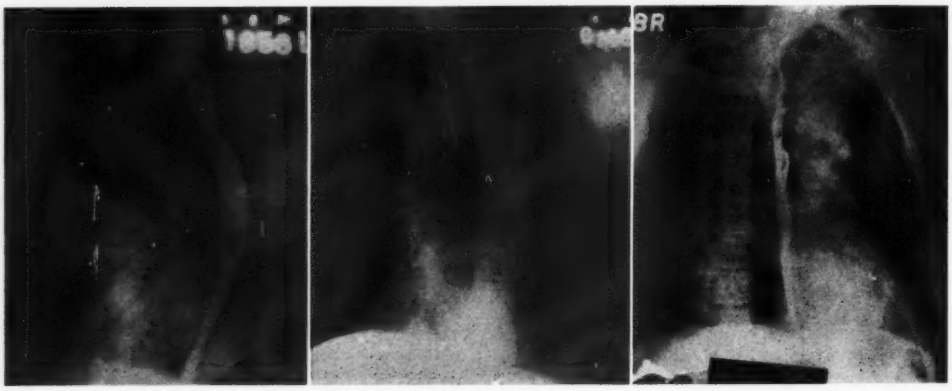


A *B* *C*

Fig. 6. Case I. *A*, carcinoma of upper third of the esophagus; *B*, radium capsule in place. *C*, one month later, irregularity is less, and dilation has disappeared.

CASE REPORTS

Case I. S. E., male, 52 years of age, complained of dysphagia of four months' duration. Food did not go down. He had no pain, nausea, vomiting, or bleeding. Liquids descended easily. He had lost eight pounds in weight. A roentgenogram revealed an irregular filling defect at the junction of the upper and middle third of the esophagus. The radium capsule was inserted as follows: three 10-mgm. tubes for 48 hours; three weeks later, three 10-mgm. tubes for 48 hours; three weeks later, two 10-mgm. tubes for 44 hours; six days later, two 10-mgm. tubes for 48 hours; eight days later, two 10-mgm. tubes for 48 hours. The total dose thereby administered was 5,600 mgm.-hours over a period of eight weeks. Shortly after the last radium insertion, the patient was able to swallow with greater ease, gained six pounds in weight, and felt well. Unfortunately, this patient who appeared to respond well was seized with the epidemic respiratory infection of last year, and died of a pneumonia following such an attack (Fig. 6).



A *B* *C*

Fig. 7. Case II. *A*, large, irregular lumen in upper third of the esophagus. *B*, radium in anatomical area corresponding to lesion. *C*, lumen smooth and even.

A *B* *C*

Fig. 8. Case III. *A*, carcinoma in lower third of the esophagus near the cardiac end. *B*, radium capsule in corresponding area. *C*, some widening of previously constricted lumen.

Case II. J. S., male, aged 60, complained of hoarseness and pain in the chest of six weeks' duration. A roentgenogram showed a filling defect at the junction of the upper and middle third (Fig. 8). A radium capsule with two 10-mgm. tubes was inserted and held in place for 17 hours. Five days later another application was given for 21 hours, and 15 days later, another for 65 hours, this time using the three-tube capsule. An esophagoscopy was then done, and a small tab of tissue removed disclosed histologic evidence of fibrosis with several scattered malignant epithelial cells. Three weeks later, another capsule with three 10-mgm. tubes was inserted for 40 hours. The total dose was, therefore, 3,900 mgm.-hours. Two months subsequent to the last treatment the patient suffered a sudden hemorrhage from the mouth and died within several minutes. At necropsy, the esophageal lesion was found scarred but there was extension above and into the left subclavian artery (Fig. 7).

Case III. W. V., male, aged 58, complained of dysphagia of six months' duration and a loss of 20 pounds during the same interval. An x-ray examination showed a linear filling defect in the lower third of the esophagus next to the cardia of the stomach.

A radium capsule with two 10-mgm. tubes was kept in place for 24 hours; three days later, the same capsule for 24 hours, and four days later, a three-tube capsule was inserted for 48 hours, the total dose of 2,500 mgm.-hours having been given. This patient with arteriosclerotic heart disease, soon developed ascites and jaundice. The course was rapidly downhill, without great improvement, and he died one month after the last radium insertion. At postmortem, the esophageal lesion was found with little response to the radium therapy and metastases to the liver and pancreas were present (Fig. 8).

CONCLUSIONS

We offer this esophageal applicator as a simple and effective means of placing and keeping radium tubes in a carcinoma of the esophagus. The sound is simply constructed, easy of insertion, with slight discomfort, if any, either during application, or in the interval when it is in place. This method obviates esophagoscopy or gastrostomy. We feel that if insertions can be made simply, and repeated as often as indicated, and without any operative intervention, a new field in this form of tumor therapy may be opened. In any event, palliation is accomplished in the simplest manner.

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PANCREATIC LITHIASIS, WITH A CASE REPORT AND AUTOPSY FINDINGS

By WILLIAM A. MARSHALL, M.D., *Chicago*

PANCREATIC lithiasis was first described by Graaf in 1667. It is a rare condition, only 147 cases having been reported in the literature so far. The case to be reported now will be the one hundred forty-eighth case.

Etiology.—The exact etiology is not known. Stasis of pancreatic secretion apparently does not produce stones. Mann and Giordano have shown that ligation of both pancreatic ducts in animals does not produce stones. Also a back-flow of bile into the pancreatic ducts will not do it. Most of the stones that have been examined contained calcium carbonate and calcium phosphate. The normal pancreatic secretion does not contain either one. However, chronically inflamed tissues may produce calcium. The assumption, therefore, is that the stones are formed either on account of a chronic inflammatory process in the ducts or due to some chemical alteration in the pancreatic secretion.

Pathology.—Pancreatic stones are mostly multiple, and are distributed throughout the pancreas. However, cases have been described with only a solitary stone which then is mostly in the head of the gland.

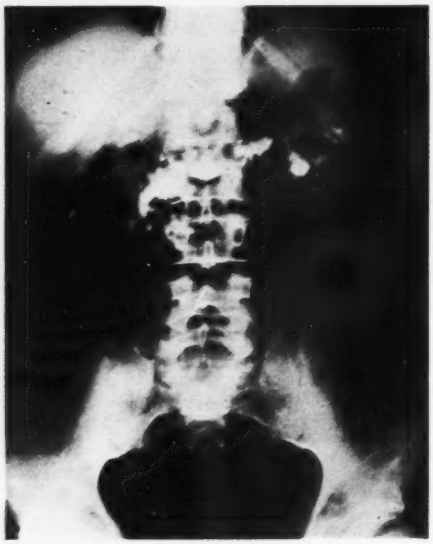

Fig. 1.

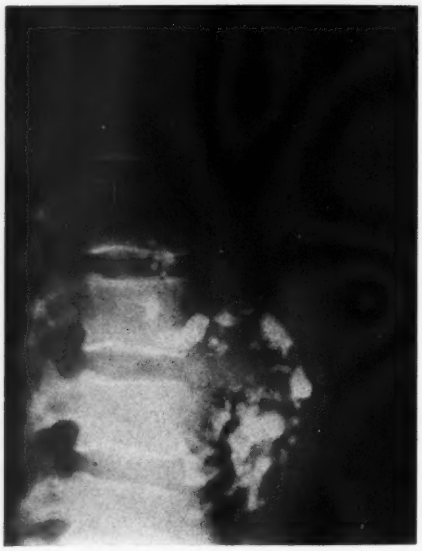

Fig. 2.

Fig. 1. Postero-anterior view of abdomen showing the pancreatic concretions following closely the anatomical location of the pancreas.
Fig. 2. Lateral view of the abdomen.

The stones are mostly the size of a cherry stone or slightly larger. Occasionally small gravel-like concretions are found. Sometimes the ducts are incrusted with sand. The largest stones were described by Shupman and Matoni. Shupman's stone measured 2.5 × 0.5 inches and weighed 200 grains. Matoni reports one stone weighing two ounces. The stones are white or grayish-white in appearance and irregular. Seldom are they facetted. They produce a chronic interlobular pan-

creatitis and in the late stages a fibrosis of the interstitial tissue. It is only in the late stages that, due to the fibrosis, the islands of Langerhans are destroyed. Therefore, diabetes does not occur until quite late in the disease.

Symptoms.—The most outstanding symptom is pain in the epigastric region. This pain may be either dull and more lasting in character, or colicky and very sharp but of shorter duration. It generally radiates into the back, very often into the left side. Sometimes the pain is agonizing in character, associated with vomiting, cold sweats, and collapse. Some attacks are similar to those due to gallstones. Minnich and Holzmann found fragments of stones in the stools after each attack. Lack of appetite and loss of weight are common. The weight loss is probably due to impairment of the digestion on account of lack of pancreatic secretion, following the atrophy and destruction of the glandular tissue. Jaundice has been found quite frequently, due to (1) stone obstruction of the papilla of Vater, (2) pressure on the bile ducts, or (3) co-existing biliary disease. Diarrhea was present quite often. Sometimes there were fatty stools. Most writers report that diabetes occurs either quite late in the course of the disease or not at all, because usually the islands of Langerhans are destroyed only when a secondary fibrosis or cirrhosis sets in. The specimen obtained through operation in our own case showed complete destruction of the pancreatic glandular tissue but the islands of Langerhans were well preserved.

Complications that may follow the presence of stones are abscess formation, cyst formation, carcinoma, duodenal ulcer, and appendicitis.

Diagnosis.—A correct diagnosis has seldom been made before operation. The most important means of arriving at a positive diagnosis is the flat roentgenogram. The stones usually contain calcium carbonate and calcium phosphate and they can readily be demonstrated on the x-ray plate. The differential diagnosis between pancreatic stones and calcified mesenteric glands is sometimes difficult. Since the advent of the gall-bladder dye it should always be possible to exclude gallstones. During the routine gastro-intestinal examination the barium-filled stomach may lie just in front of the pancreas and pancreatic stones may be missed. If, therefore, in the presence of epigastric pain the usual gastro-intestinal examination is negative, it is advisable to keep the possibility of pancreatic stones in mind and to take a plain film after thorough evacuation of the barium. The correct and early diagnosis of stones in the pancreas is of great importance because in many cases surgery can bring complete relief, before an extensive destruction and atrophy of the grandular tissue has taken place.

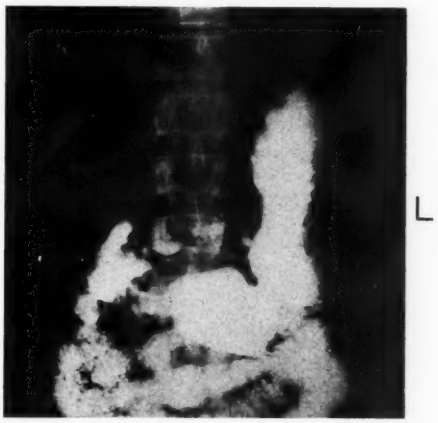

Fig. 3. Postero-anterior view of abdomen after barium meal, showing many of the concretions covered by the stomach. The presence of the stones may easily be overlooked during the routine gastro-intestinal examination.

Treatment.—The most efficient treatment is operative. Bost reviewed 28 cases that were operated on; the mortality was about 7 per cent. The post-operative results were very good. Fat necrosis or post-operative fistula did not follow the operation, which consisted mostly of removal of the stone and the drainage of abscess or cysts.

SUMMARY

1. Pancreatic lithiasis is a rare disease. The most constant symptom is pain in the epigastric region radiating toward the back or toward the left side.

Fig. 4. Postero-anterior view of abdomen after the administration of a barium enema.

2. The presence of epigastric pain without demonstrable lesions in the stomach or in the gall bladder should arouse the suspicion of pancreatic lithiasis.

3. The most important means of arriving at a diagnosis is a plain x-ray view of the upper abdomen. The routine gastro-intestinal study with the use of barium may hide the stone.

4. Early diagnosis is of extreme importance as timely surgery may cure the patient by preventing atrophy and destruction of the glandular tissue. The most efficient way of treating pancreatic lithiasis is surgical removal of the stones.

REPORT OF CASE

The patient, Mr. H. F., a German toolmaker, 48 years old, gave the following history: He had been quite well until three months before when he began to develop a pain in the epigastric region and in the back, radiating toward the left lumbar region. This pain was of a dull character, would last about 20 minutes, and then disappear for about three or four hours. It would be relieved by taking aspirin. It had no relationship with meals. He had lost about 10 pounds in weight during the last three months. Physical examination showed a fairly well-nourished man who did not appear acutely ill, weighing 133 pounds. He was five feet six inches tall. Pulse rate, 88, blood pressure 144/96. On palpation of the abdomen there was a definite tenderness in the epigastric region and in the left upper quadrant. Below the left costal arch there was also some rigidity. On firm pressure some small nodules could be felt in this area. The urine analysis showed no albumin or sugar. There were 25 to 30 pus cells per high-power field and occasional blood cells. Some mucus was present. The blood examination showed 4,970,000 red blood corpuscles, 6,200 white blood corpuscles. Hemoglobin was 100 per cent. The differential count showed 62 per cent polymorphonuclear, 24 per cent small mononuclear, and 14 per cent large mononuclear. There was some anisocytosis and poikilocytosis. A gastro-intestinal x-ray examination was done. The postero-anterior view of the stomach after the administration of a barium meal showed a negative stomach and duodenal cap. Above the pyloric area several irregular-shaped shadows were seen that were first thought to be mesenteric calcified glands (Fig. 3). After thorough evacuation of the barium meal a flat plate was taken which showed numerous irregular calcareous shadows in the upper abdomen closely following the anatomical location of the pancreas (Fig. 1). The patient was admitted to the Alexian Brothers Hospital July 28, 1937. During the following few days there was no marked improvement. He had poor nights and complained of repeated attacks of sharp pain. On Aug. 4, an exploratory laparotomy was done (Dr. A. G. Zimmermann). Through a median incision above the umbilicus the

upper abdomen was explored, and above the transverse colon below the liver a hard nodular mass was discovered in the retroperitoneal space. The tumor was left in place but a portion was removed for biopsy. A drain was inserted and the abdomen was closed. The pathologic report as given by the pathologist, Dr. J. P. Simonds, reads: "Stone in pancreatic duct with complete atrophy of the parenchyma of the pancreas in the tissue removed, leaving only the islands of Langerhans." The patient had a stormy post-operative course. He developed a high temperature, was mostly very restless, coughed severely, and complained of severe pains through the chest. The ordinary medications did not relieve the cough. He became more and more dyspneic and died Aug. 16 (12 days after the operation) under pulmonary and cardiac symptoms.

Autopsy Findings.—The following anatomical diagnosis is an abstract of the autopsy findings as reported by Dr. J. P. Simonds:

1. Multiple concretions of the pancreatic duct.
2. Dilatation of the pancreatic duct.
3. Marked atrophy of the pancreas.
4. Carcinoma of the body of the pancreas.
5. Recent surgical removal of a portion of the atrophied pancreas.
6. Lobular pneumonia, bilateral.
7. Gangrene of the lungs, most marked in right lower lobe.
8. Edema of the lungs.
9. Acute fibrinopurulent pleurisy, right side.
10. Occlusion of splenic vein by tumor growth.
11. Passive hyperemia of the spleen.
12. Multiple recent infarcts of the spleen.
13. Metastatic carcinoma of the liver and lungs.
14. Parenchymatous degeneration of the liver and kidneys.
15. Localized acute gastritis and perigastritis.
16. Deficient yellow pigment in adrenal cortex.
17. Eustachian valve in right auricle.
18. Focal fibrous adhesion in left pleural cavity.
19. Gauze drain in upper abdominal cavity.
20. Recent laparotomy surgical incision.
21. Needle puncture wound in right antecubital space.

The pancreas is thickened and indurated, particularly in its middle portion. It measures 18 cm. in length and in the middle portion is 6.5 × 4.5 cm. in diameter. There is a mass of slightly hemorrhagic and discolored (brown) tissue at the junction of the middle third and the lateral portion, forming a lining for an irregular cavity. The latter contains several surgical sutures, and a thin coating of fibrinous exudate is present both in the cavity and on the anterior surface of the pancreas. The pancreatic duct is unevenly dilated, reaching a maximum diameter of 15 mm., and filled with closely packed concretions of various sizes and shapes. The largest single stone measures 2.5 cm. in length and up to 12 mm. in diameter. The surfaces of the stones are finely granular, and white to yellowish-white. Surfaces made by section through the indurated portion of the pancreas show pale yellowish-gray, moist tissue, which suggests an infiltration with tumor tissue rather than purely a fibrous induration. The pancreatic tissue of the medial and lateral thirds appears to have been completely replaced by fibrous and adipose tissue. The opening of the pancreatic duct at the ampulla of Vater admits a 1 mm. size probe.

I am indebted to Dr. Leopold Frey for referring this case to me, and to Dr. J. P. Simonds for furnishing the autopsy reports.

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Only the most recent references are listed. An extensive review of the older literature dating back to the middle of the last century was compiled by Seeger (25).

FOREIGN BODY LOCALIZATION IN MILITARY ROENTGENOLOGY[1]

By CAPTAIN EDWARD K. REID, A.B., M.D., Medical Corps Reserve, *and* STAFF SERGEANT LAWRENCE F. BLACK, Medical Department, U. S. Army

From the Department of Roentgenology, Army Medical School, Lieut. Colonel W. W. McCaw, Medical Corps Director, Washington, D. C.

THE problem of localization of foreign bodies is one of the most important considerations of military roentgenology. Since 1919, almost coincident with the end of the military surgery of the World War, there has been very little progress or attention paid to this subject in the United States.

It is the purpose of this paper to give a brief tribute to the excellent work done in the correlation of radiographic foreign body localization by James T. Case (35), J. S. Shearer (123), David R. Bowen (16), and the collaborators on the U. S. Army X-ray Manual (137) in 1918; to report the important methods described since the publication of these works in recent years; to correlate terminology and classify the many methods described under the heading of principles involved, and to outline the present recommendations approved by the Office of the Surgeon General for use in case of a national emergency.

Mention of the methods found in our search of the English literature will be made, with references for those who wish to delve more deeply into the subject. That it is obviously impossible to describe every method ever published will appear at once to anyone attempting to cover this subject. No doubt many references will be available in addition to those which we mention; in fact, a direct attempt has been made to delete from this study any report which did not add to the knowledge of the subject. It has also become necessary, because of the length of the discussion, to omit the consideration of foreign bodies in the eye and food and air passages, considering them as a distinct and separate topic. It will also be seen that the many interesting developments of so-called "slice radiography," such as the Laminograph, the Subtraction Method, special bi-plane fluoroscopy and other methods which require large amounts of special apparatus, are not subject for consideration here as they are still somewhat experimental and are impractical for the average small installation.

That this paper has a twofold mission must be recognized at once. First, it is an attempt to assemble and classify the knowledge of the subject under one heading for easy reference in the case of emergency, and second, it is an outline for the guidance of the Military Medical Service in the methods approved by the Surgeon General of the Army.

In carrying out our first objective we refer to Dr. Case's (35) and Dr. Bowen's (16) articles to bring the knowledge of the history of the various methods up to 1918. To attempt a summary or condensation of the material included in these papers would do them injustice and slight a very interesting portion of the knowledge of this subject.

In 1918 we find that Major J. S. Shearer published a paper (123) in which he described the "Standard Methods Approved by the Surgeon General's Office, U. S. Army, for Localization of Foreign Bodies." This paper undertakes a complete description of the following methods:

1. Two-wire, Double Tube Shift Method of Strohl.
2. Parallax Method of Blaine.
3. Tube Shift with Mechanical Triangulation.
4. Profondometer of Flint.
5. Hirtz Compass with accessory devices.
6. Sutton's Cannula and Trochar with Harpoon.

[1] Approved by the office of the Surgeon General, U. S. Army, Washington, D. C.

7. Fluoroscopic Guidance with intermittent control.

These methods are also explained in detail in the U. S. Army X-ray Manual, first edition (137), and an added insert is found in this volume describing the Nearest Point Method.

No further publication concerning this work, as far as the Army is concerned, is found until 1932, when Lt. Col. Pillsbury presented the Second Edition of the Manual (138). In this work the following methods are approved:

1. Two-wire, Double Tube Shift Method of Strohl.
2. Nearest Point Method.
3. Radiographs at right-angle planes (Two-plane Method).
4. Operative removal under the fluoroscope.

It is to be seen from this that the Parallax Method of Blaine, Tube Shift with Mechanical Triangulation, Profondometer of Flint, Hirtz Compass, and Sutton Cannula and Trochar methods were deleted from the teaching text of military roentgenology between the years of 1918 and 1933. The reason for this action was not necessarily because of any lack of value of these methods but because of the inherent difficulties of their successful application in the ordinary roentgenological installation.

The textbook of the Army Medical School, Department of Roentgenology, entitled "Roentgenographic Physics for Officers and Enlisted Technicians," by Lt. Col. W. W. McCaw (101), instructs in the following methods:

1. Two-wire, Double Tube Shift of Strohl.
2. Modification of Single Tube Shift and Mechanical Triangulation (very much as described by Trout, 135, 62).

This shows a return to the Single Tube Shift Triangulation Method but does not give detailed instruction in the Nearest Point Method, Two-plane Method, and Fluoroscopic Guidance; the only method to survive all these studies is the Double Tube Shift, Two-wire Method of Strohl.

A survey of a number of the best standard textbooks published in the five-year period ending January, 1937, shows the following methods discussed:

1. *Outline of Radiology*, Educational Committee, Pennsylvania Radiological Society, 1937 (54).
   (*a*) Strohl Two-wire, Double Tube Shift Method—described in detail.
   (*b*) Parallax Method—merely statement of principle.
   (*c*) Single Tube Shift with Mechanical Triangulation (apparently not so common as *a*).
   (*d*) Profundometer—stated to be non-practical.
   (*e*) Hirtz Compass with accessory devices—stated to be complicated and impractical.
   (*f*) Cannula and Trochar with Harpoon—regarded as least desirable method.
   (*g*) Profunda Method—described.
   (*h*) Stereoscopic Method—merely mentioned.
2. Textbook of Diagnostic Roentgenology, Friedman, 1937 (59).
   (*a*) Two-plane Method (right-angle films).
   (*b*) Single Tube Shift with Triangulation—not described in detail.
3. Textbook of Roentgenology, Harrison, 1936 (77).
   (*a*) Two-plane Method.
   (*b*) Nearest Point Method.
   (*c*) Stereoscopic Films.
   (*d*) Single Tube Shift with Triangulation.
   (*e*) Biplane Fluoroscopic Guidance—not described in detail.
4. Roentgen Interpretation, Holmes and Ruggles, 1936 (81).
   (*a*) Biplane Fluoroscopy.
   (*b*) Nearest Point Method.
   (*c*) Modified Strohl Method.
   (*d*) Fluoroscopic Control.

5. Roentgenographic Technic, Rhinehart, 1931–1936 (117).
   (*a*) Fluoroscopic Control and Guidance.
   (*b*) Two-plane Method.
   (*c*) Single Tube Shift with Triangulation—in detail.
6. X-ray Studies III, General Electric Co., Trout (135, 62).
   (*a*) Single Tube Shift with Triangulation.
7. Manual of Radiological Technic—Sante, 1935 (118).
   (*a*) Fixed Angle Method of Strohl.
   (*b*) Parallax—statement of principle.
   (*c*) Profunda.
   (*d*) Combined Profunda and Parallax.
   (*e*) Barium Wash.
8. Jerman and Köhler make no mention of the subject.

CORRELATION OF TERMINOLOGY AND CLASSIFICATION OF METHODS BY PRINCIPLE INVOLVED

I. Fluoroscopy Principle.
   (*a*) Simple fluoroscopic localization; to include general survey methods (117, 137).
   (*b*) Removal of foreign bodies under simple fluoroscopic guidance (137, 117, 103, 16, 33, 31, 5, 123).
   (*c*) Biplane fluoroscopy; two tubes and two screens at 90 degrees to each other (77, 102).
   (*d*) Stereo-fluoroscopy; Caldwell, Imboden, Mackenzie Davidson. Alternately energized tubes with shutter arrangement applied to stereoscopic view system (29, 35, 104).
   (*e*) Bonnet fluoroscope; Eastman and Bettman (35, 53).
   (*f*) Intermittent fluoroscopic control of Ledoux-Lebard. Intermittent fluoroscopy using bonnet fluoroscope (16).

II. Single Tube Shift Principle.
   (*a*) Single Tube Shift, two exposures on one film (59, 62, 77, 101, 117, 135).
   (*b*) Single tube shift with Mechanical Triangulation (35, 54, 137). Many variations and reports of the principle include: Levy-Dorn and Gerard (35); Buguet and Gascar (35); Harrison (76); Turner (136); Wagg (139); Mergier—same principle but used two tubes instead of shifting one (35); Galeassi—with direct reading scale (35); Guilloz (35); Perdu (35); Muller (35); Kreuzfuchs (35); Manuel and Nogueras (35); Jaugeas (35); Charlier (35); Clark (36, 37); Colardeau (35); Coleschi (35); Cotton (41, 42); Davidson (46); Duncan (51); Hallam (70); Hampson (73, 74); Jallot and Guerrea (35); Lagoutte (35); MacKenzie (96); Menard (35); D. R. Shearer (122); Stenning (129); Viallet and Dauvillier (35); Thurstan-Holland (134); Desplats (50); Laroquette and Lemaire (35); Mahar (35); Oram (109); Gamlen (61); Kirkwood (88); Deverre (35); J. S. Shearer (123).
   (*c*) Simple Tube Shift of Haret. Fluoroscopic method using tube shift and markings on screen with interpretation on triangulation (16).
   (*d*) Cross-thread Method of Mackenzie Davidson. Utilizes principle (*a*) plus use of cross-threads and necessity for reproduction by fixed reference—solved by triangulation (16, 43, 44, 45); also Hedley modification (78).
   (*e*) Granger Method. Single tube shift—fluoroscopic with special measuring device (64, 65, 66).
   (*f*) Remy Method. See Compass and Grid (VIII—*h*).

(*g*) Little's Method apparently contains nothing not previously described—a direct reading scale for single tube shift and triangulation (91).

(*h*) Localizing Profundoscope. Single tube shift with a special template in the fluoroscope screen (described in this paper).

III. Double Tube Shift Principle.

(*a*) Strohl Fixed-angle Method (described in this paper in detail, 54, 118).

(*b*) Strohl Two-wire Method. A modification of (*a*) with reference points by opaque wires on tube head (101, 123, 137).

(*c*) Davidson Method. A complicated cross-wire method using a permanent installation modification of the Strohl Method (47).

(*d*) Cole Method (see IX—*f*).

(*e*) Moppett Method. Double tube shift in a permanent installation with a series of lever attachments to support and move tube and screen in unison (106).

IV. Two-plane Film Principle.

(*a*) Two films at 90 degree angle to each other (59, 117); also White, Goodspeed, and L. Leonard (142); Stechow (35); Wilson (146).

(*b*) See Bi-plane fluoroscopy with permanent record films.

V. Parallax Principle (123, 137).

(*a*) The localization of a foreign body by observation of the shadow upon the fluoroscopic screen while the tube is moving at determined distances from the body.

or

(*b*) The image cast by an object on a fluoroscopic screen moves less and less as the object gets nearer the screen.

Methods

(*a*) Blaine Method. Parallax Principle with special opaque markers on a calibrated stand; commonly called Double Ring Method (9).

(*b*) Redner Method. Similar to (*a*); employs double rings (35).

(*c*) Young Parallax Method. A duplication of previously reported method by Le Faguays (35, 147).

(*d*) Nearest Point Method. Use of opaque tipped rod to move foreign body; the nearest point causes the greatest movement (54, 75, 77, 118, 137, 141).

(*e*) Method of Le Faguays. Pure Parallax—not presented in English (see Young).

(*f*) Shenton Method. Pure Parallax (126, 127).

(*g*) Parallax Principle also discussed by: Levy-Dorn (35); Exener (35); Angerer (35); Sherwald (35); Jordan (86); Le Faguays (35); Pirie (114); Grandgerard (35).

Notes.—The Nearest Point Method was first described by Wildt (35), later by Holzknecht (35) and Harris (75). It will be seen that many methods revert eventually to the Parallax Principle. They are considered in this study, however, on the basis of their most outstanding or revolutionary feature. Upon study, many methods described as Parallax Principle are found to be in some other class.

VI. Opaque Instrument Invasion of Wound Principle.

(*a*) Sutton Cannula and Trochar with Harpoon. Localization by trochar and cannula under the fluoroscope—harpoon is introduced and bent to the skin

for aid to surgeon (16, 54, 94, 128, 130, 137).

(*b*) Profunda Method. A direct operative procedure under the fluoroscope for guidance. Forceps are directed straight downward in plane of central ray to grasp the object (54).

(*c*) Profunda Method Modified by Parallax. A combination of the two methods used in instances in which the lateral approach is indicated (54, 118).

(*d*) Bruce's Compass with Needle in Tissue. Modification of Sutton Method (24, 25, 35).

(*e*) Flint's Band and Guide. Opaque strip about the body of patient and a V-shaped indentation to invade the wound at the site of the foreign body (56, 57).

(*f*) Perthes' "*fromdkoerperpunktion*" (35).

VII. Localization by Reference to Opaque Bodies on the Skin.

(*a*) Flint Profondometer. Credited to Irwin. Any opaque flexible material in bands moulded to skin and used as a reference point (16, 54, 56, 57, 137).

(*b*) Tripod Band Guides. Modified Profondometer on a tripod support (16).

(*c*) Bailey's Malleable Strip Method. Modification of the Profondometer in several planes (2, 35).

(*d*) Blaine's Cross-section Anatomical Localization Method. Modification of Profondometer applied to anatomical cross-section charts (11).

(*e*) Jordan Localizer. Two rods at 180 degrees on a vertical scale beneath a fluoroscopic screen (86).

(*f*) Walsh Barium Wash. Small foreign bodies near the surface, as a needle in the hand. The skin is washed in barium and identification made by position in regard to visible markings on the skin made by residual barium (118,140).

(*g*) Brown and Young Method. Reference to Bismuth-iodoform-paraffin paste in wound tract (21).

(*h*) Multiple Opaque Rods of Caldwell. Reference to fixed multiple rods at angles to area of suspected foreign body (28, 35).

(*i*) Direct Method of Morize. Utilizes Ring Pointer and four lead skin disks (Parallax, 16, 35); also Araujo (35).

(*j*) Cole Method. (See IX—*f*.)

(*k*) Warluzel and Jollant Method. (Probably first Profondometer method, 35).

(*l*) Fox Method. Profondometer in Brain Localization (58).

(*m*) Hernaman - Johnson Method. Four points on skin, Ring Localizer (85).

(*n*) Lebon Method. Profondometer with bands and block of tin (35).

(*o*) Belot, Fraudet, Nogier Method. Ring localizing method with special forceps (35).

(*p*) Blaine Caliper Method. Use of calipers for reference (8).

VIII. Compasses and Grids Principle.

(*a*) Blaine Parallax Method modified by a Ruled Celluloid Grid (137).

(*b*) Hall-Edwards Grid. Ruled Grid for reference; direct reading (35, 71).

(*c*) Dennis Fluorometer. Upright and Horizontal Grid on the fluoroscopic table with wood cuts-outs to support limbs (35, 48, 49).

(*d*) Hirtz Compass. A complicated method with multiple opaque rods on a stationary compass (16, 54, 137).

(*e*) Shearer's Permanent Installation of Hirtz Compass (124).

(*f*) Marion-Danier Localizer. Compass Method of using Mackenzie Davidson Principle (Single Tube Shift with Cross-threads, 16, 35).

(*g*) Debierne's Compass. Arc bar and pointer for easy reference for the surgeon (16).

(*h*) Remy Method. Single tube shift—fluoroscopic—with two set compass directors; for use on the operating table (116).

(*i*) Shaxby Ladder Grid. Similar to Dennis Fluorometer (35, 120, 121).

(*j*) Tousey's Grid Method. A continuation of older grid methods (35, 133).

(*k*) Stenning Localizer Mat. A grid method with wires in a mat for reference (35, 129).

(*l*) Sechehaye Grid Method. Complex in the extreme; much mathematics. Also described by Van der Goot (35).

(*m*) Contremoulins Compass. The forerunner of the Hirtz (35).

(*n*) Kocher Compass. No new principle; guide for surgeon (35).

(*o*) de Laroquette Compass. A simplified Hirtz but correspondingly less useful (35).

(*p*) Loro Radiological Sextant. Reference device (35).

(*q*) Marechal Compass. For operative guidance (35).

(*r*) Modifications of Hirtz Compass by; Chaperon and Vanderhaeger, Charlier, Morin, H. Béclère (35).

(*s*) Aime Method. Hirtz Compass with fluoroscope (35).

(*t*) Shaver and Simpson Method. Single tube shift with grid above patient, fluoroscopic and film method with wall charts (119).

IX. Combination of Two or More Principles.

(*a*) Thompson Method. Two-plane fluoroscopy with simple triangulation and the use of a special measuring device with opaque wires (132).

(*b*) Hall-Edwards Method. Two-film, single tube shift with definitely placed opaque markers—may be read either stereoscopically or by measurement (35, 72).

(*c*) Desplats Method. Single tube shift and return excursion with opaque markers on skin. Two marks on the screen with each shift. Correction and measuring done at room light (50). Modification. (See X—*k*.)

(*d*) Two-axis Method of Debierne. Uses multiple skin marks on separate views. Requires moving patient (50).

(*e*) Combined Profunda and Parallax. (See VI—*c*.)

(*f*) Cole's Double Tube Shift and Triangulation with Use of Profondometer (35, 39).

(*g*) Jordan's Equal Shadow Shift. Combines Parallax, two opaque rods, and double tube shift (16, 86).

(*h*) FitzWilliams Method. Used Nearest Point followed by Profunda Method of Removal (55).

X. Miscellaneous Methods and Devices.

(*a*) Stereoscopic Films.

(1) Beck and Smith (5, 54, 77, 6).
(2) Imbert and Bertin (35).
(3) E. Thompson (35).
(4) Marie and Ribaut (35).
(5) Lambertz (35).
(6) Carothers (35).
(7) Bouchacourt (35).
(8) Gillet (35).
(9) H. Béclère (35).
(10) Mayer (35).
(11) Colombo (35).

(12) Ribaut and Brock (35).
(13) Buchbinder (26); also used opaque markers with stereoscope.
(14) Iles (83).

(*b*) Caldwell's Calipers (28, 35).

(*c*) Little's Calipers (92).

(*d*) Blake's Triangulation Method. A complex mathematical process of reporting other principles (15, 35).

(*e*) Cardboard Cut-outs of Vergeley. A method of translation of findings by other methods (16).

(*f*) Bramwell Arithmetical Aid. An aid, not a method (19, 35).

(*g*) Hedley's Telephonic Probe (35).

(*h*) Thomas Instrument. (Similar to *g*, 131).

(*i*) Barclay Bell-ringing Forceps Localizer (3, 35).

(*j*) Anatomical Localizations and Orthodiagrams—many methods. Desplats (50); Moritz (35); Herrman (80).

(*k*) Desplats Caliper Modification of Own Method. Uses calipers instead of turning patient (50).

(*l*) Central Ray Localization. A discussion of basic principle (16).
(1) Barrell Metal Cylinder Method (4, 35, 28).
(2) Blake's Modification of Barrell Method (12, 13, 14, 35).

(*m*) Carver's Method. A reverse modification of the Single Tube Shift Principle in that the tube remains stationary but an opaque pointer is moved and the shift of it measured. The vertical ray is one reference point (16, 34).

(*n*) Blaine's New Holder for Trochar and Harpoon Localizer. A modified Wedel needle holder for holding the cannula (10).

(*o*) Busby Method. A three-position tube shift with special modifications of Dessane's Fluoroscopic Screen with crosswires and marking device for the skin. Opaque markers on the skin and direct reading scale (27).

(*p*) Formula of Buget and Cascar:

$$\text{Depth} = \frac{b \times h}{a + b}$$

a, Tube distance.
b, Shadow shift.
h, Height screen-anode.
Later by Bermbach (35).

(*q*) Wentzlik Method. A small chain and silver nitrate marks on the skin for reference (35).

(*r*) Caleazzi Method. A pierced fluoroscopic screen for marking the skin through the hole (35).

(*s*) Preventograph of Addymann. Really a simple ring localizer (35).

(*t*) Furstenau Calipers. A direct reading method. Described by Reichmann (115).

(*u*) Coon Method. A method for civil practice (35).

(*v*) Manges Method. In Roentgen Pelvimetry, suggests its use in foreign body work (35).

(*w*) Wullyamoz Forceps. Blades at right angles to shaft to protect the operator from the roentgen rays. Also described by Laval (35).

(*x*) Raoult-Deslongchamps Method. A fluoroscopic method with one eye control while the other eye watches the surgical field (35).

(*y*) Le Nestour suggested a tent for the anesthetist so that the operative field could be kept dark (35). (He seems to have overlooked the surgeon.)

(*z*) Baese Method. The tube and screen move together (35).

(*aa*) Lefort Magnetic Guidance under fluoroscopic control (35).

(*ab*) Castelvecchio and Pittarelli Method. Complex mathematical calculations; no advantage over previous methods (35).

(*ac*) Kaufmann Method. For long, slender, opaque bodies. A magnetic removal with a mathematical calculation (87).

(*ad*) Ledoux-Lebard has used thermo-cautery for skin marking (35).

Case Reports.—By Aldridge (1); Bowker (17); Brissande and Londe (20); Bruce (23); Gray (67); Marsh (98); McCausland (100); Morris (107); Phelps (113); Griffith and Pearse (69); Herring (79).

General Discussions.—By Reference (7, 18, 22, 32, 38, 40, 52, 60, 63, 68, 82, 84, 89, 90, 91, 93, 95, 99, 105, 108, 110, 111, 112, 114, 125, 143, 144, 145).

Note.—It is obvious that many methods have been described which are duplications of previous work. It is possible that some method may have been inadvertently overlooked in our search. We will appreciate any information from readers of such an omission, so that the record may be made complete.

Classification has been attempted on the basis of the most outstanding or most revolutionary method involved. This was done for ease in reference.

Due to the fact that the Strohl Double Tube Shift Two-wire Method has been shown to be the only method to survive the elimination process of the instruction literature of the U. S. Army, it is herein described.

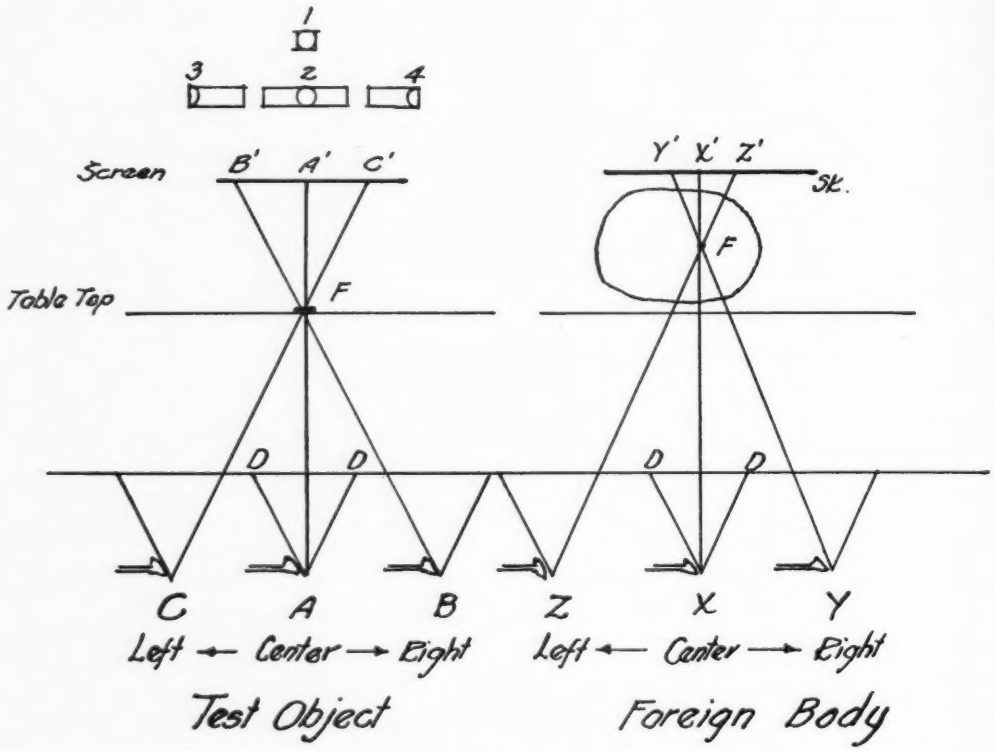


Fig. 1. Strohl fixed angle method.

STROHL TWO-WIRE DOUBLE TUBE SHIFT METHOD

This method is based on the Strohl Fixed Angle Method here noted as described in the *Outline of Radiology* of the Pennsylvania Radiological Society (54).

Fixed Angle Method of Strohl.

(*A*) Double tube shift method with mechanical triangulation.

1. Center tube to test object lying on table top.
2. Open slit to maximum width on fluoroscope diaphragm.
3. Displace tube toward right end of slit until margin of diaphragm *D* coincided with object; mark position on screen with wax pencil *B*.
4. Displace tube to left end of slit until margin of diaphragm coincides with object; mark on screen *C*.
5. The ratio of the distance of these two marks on the screen to the actual measured distance of the table top to the screen may be used in all subsequent localizations.
6. To localize foreign body in the tissue, go through similar procedure; shift right and left. By this means two similar triangles are obtained: $B'TC'$ and $Y'FZ'$ where Y' and Z' equal points on screen, right and left, and F equals position of foreign body.
7. In similar triangles the ratio of base to the altitude of one is equal to the ratio of base to altitude of the other and since three of these values can be measured it can be solved for the fourth, or the depth of the foreign body from the screen.
8. If skin is not in contact with screen measurement allowance must be made.

The two-wire method is a modification of this in which a sheet of transparent material, with two lead or steel wires fastened at a fixed distance apart (4 in.), and placed at a fixed distance of 6 in. from the tube target, is attached to the shock-proof head of the fluoroscope. These wires are used as reference points for limit of beams.

The interpretation requires calculation but can be aided by a special rule or screen markings.

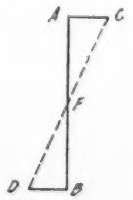
The consensus of opinion of both the military text books and of civilian authorities gives both the preceding method and the Single Tube Shift with Triangulation the highest number of votes by far, and since the Localizing Profundoscope, the method approved in this study, is based on a modification of the latter method in principle, it is here described in detail.

SINGLE TUBE SHIFT WITH TRIANGULATION (135, 101)

(*A*) Method.

1. Prone position — locate foreign body by fluoroscope.
2. Skin mark exactly over foreign body (must have shutters closed to a 2-in. square).
3. Place film under patient; 25-in. focal film distance. Center tube by light beam over skin mark.
4. Make exposure (light) one-third time for usual Bucky.
5. Shift tube 6 in. horizontally, make second exposure same film.
6. Draw diagrams—paper 30 × 12 in.
   Draw AE—25 in.
   Draw AC—6 in.
   Measure DB (distance between film images).
   Draw CD.
   Measure BF depth of foreign body in patient measured from skin surface nearest the film.

AB = 25 in.
AC = 6 in.
DB = measure on film
FB = depth of foreign body



Note.—This is *not* the point of the mark on the skin, but is just the opposite side of the body.

(*B*) Apparatus.
1. Fluoroscope.
2. Film equipment.
3. Skin marker.
4. Paper for computations.
5. Chart for depth curves.

(*C*) Accuracy of localization depends on:
1. Care of centering tube.
2. Care in plotting diagram.
3. Care in measuring two foreign body images.
4. Absolute immobility of patient.
5. Remembering that spot on skin is not the localization point for surgeon. (Grave danger here.)
6. Absolute suspension of motion, to include respiration, also necessary (Rhinehart, 117).

From the description it can be seen that a good method of permanent localization record can be obtained. However, the procurement plan of the Army for an emergency does not call for any work except fluoroscopy in forward installations of the Medical Department. Therefore, it was necessary for a method to be developed which could be applied to this situation and yet meet all the other requirements outlined previously in this paper. The Localizing Profundoscope as developed by Sergeant Black was the outcome, and it is described in this paper. It is believed that this method will eliminate the necessity of all other methods in this work.

PRESENT RECOMMENDATIONS OF THE SURGEON GENERAL'S OFFICE FOR FOREIGN BODY LOCALIZATION

As a basis for approval or rejection of any method for use in the U. S. Army, the following points have been listed as essentials to an efficient method of localization of foreign bodies in time of war:

1. Speed.
   Patient turn-over is rapid and evacuation must go on.
2. Accuracy.
   Unless the exact location of the fragment can be given to the surgeon, the time used in radiography is poorly spent.
3. Simplicity.
   (*A*) Of equipment.
   Each additional piece of equipment is an added hazard to loss of function due to loss or destruction of parts. Within reason, parts must be replaceable on the field or a working substitute produced. Weight and bulk are important in mobility.
   (*B*) Of operation.
   A minimum of measurements and mathematical computations essential, due to fatigue and nervous factors of operators under stress. Manipulations should not require an undue amount of skill.
4. Fluoroscopy sufficient.
   The present plan for equipment in forward medical installations allows for fluoroscopy alone.
5. Comfort of patient important, including a minimum of manipulation and position changes.

Conversely, the violation of the following factors make the system subject for rejection:

1. Necessity for reading fine scales.
2. Necessity for reading any scale in a bad light.
3. Necessity of making many calculations.
4. Necessity of drawing diagrams.
5. Necessity of changing the light intensity of the room.

General Considerations for Good Work in Localization of Foreign Bodies.—As in all branches of roentgenology, the principles of good work apply in this endeavor. Since the majority of present-day accepted methods are largely fluoroscopic, the operator must insist that—

1. A properly darkened room be obtainable.

2. Proper time be allowed for eye accommodation.
3. Patient is prepared before entrance to fluoroscopic room.
4. Preliminary examination of suspicious areas be performed in a good light and report accompany patient.
5. Apparatus is adequate and in good working order immediately prior to examination.
6. Any accessories necessary are conveniently at hand and in good working order.
7. Assistants are properly trained and act promptly and efficiently.
8. Part to be examined is placed within the

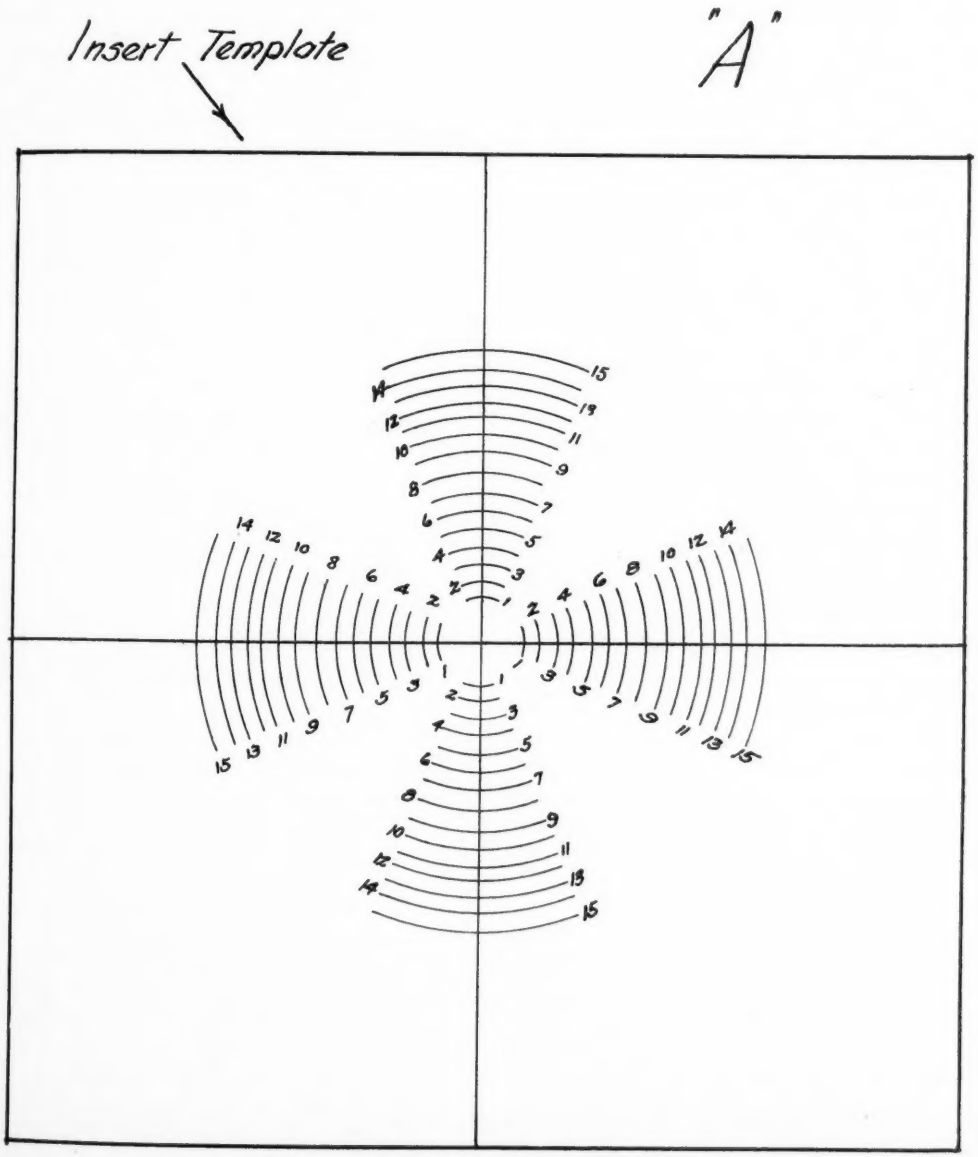


Fig. 2. Device for localization of foreign bodies.

middle one-third of the tube-screen movement.

Visualization of a foreign body will depend on the size, shape, position, density and material, surrounding tissue, immobility of the fragment as well as the technical factors of equipment and operator.

Complete roentgenological examination in cases of suspected foreign body is made up of three definite parts:

1. Survey for determination of foreign bodies present and general location. (Rhinehart, 117, states that bullets often take an unexpected path in the body, are frequently found at a distance from their place of entry, and occasionally break up into two or more fragments.)
2. Special localization for accuracy.
3. Definite clear report to the surgical department.

A secondary consideration for the roentgenologic department after the above three points have been covered is the fluoroscopic guidance of surgical removal of fragments.

Harrison (77) recommends the use of the biplane fluoroscope wherever possible for this procedure, but it must be seen that simple fluoroscopy is all that is possible in many installations. The use of the bonnet fluoroscope for intermittent control, as described by Bettman (53), is of great aid.

Harrison further makes a very important point: He warns that the position of the patient when examined must be carefully noted and reproduced in the operating room from carefully recorded data, or false impressions will be given.

For the production of this position, however, the skin must be well marked with reference points, one of the most important marks being the points of entrance and exit of the central ray (Desplats, 50).

Skin Marking.—For skin marking the following formula for ink is recommended by the United States Army (137).

Pyrogallic acid	1.0 gram
Acetone	10.0 c.c.
Liquid chloride of iron	2.0 c.c.
Wood alcohol q. s. ad	20.0 c.c.

The use of standard marks of reference point is also important and should be referred to on the written report accordingly. The following was suggested by Dr. Finzi, we are told, as a standard marking system:

Reports.—Of equal importance to the ability to localize foreign bodies accurately is the ability to report the findings to the surgeon. This report should include the following information:

Symbol	*Word Description*
⊙	Circle
⊡	Square
∠	Acute angle
△	Triangle
⌊	Right angle
×	Cross
⊂	Central ray entrance
⊂	Central ray exit

(*A*) Projectiles.
   1. Number.
   2. Their volume—metallic dust, bean size, pea size, etc.
   3. Form of each—round, cubical, elongated, sharp edge, splinter, serrated.
   4. Position with reference to permanent landmark (give actual measure).
   5. Radio-opacity or translucency.

(*B*) Trajectory in the tissues.

(*C*) Probable structural involvement.

(*D*) Report of fractures—any bone damage (follow the usual report method).

(*E*) Soft tissue damage.
   1. Fluid in anatomical cavities.
   2. Mobility of diaphragm in thorax.
   3. Movement of projectile with physiological changes.

(*F*) Superficial projectiles may be marked by designated symbols and reported in unmistakable word picture terms.

(*G*) Certain projectiles need not be localized exactly in advanced military positions as:

1. Many multiple deep fragments (merely report).
2. Small foreign bodies deeply embedded in thick regions outside peritoneal cavity far from neurovascular masses. (Indicate on report and add "to be left in place.")
3. In principle, all projectiles which are not too small or too superficial should be localized for depth.

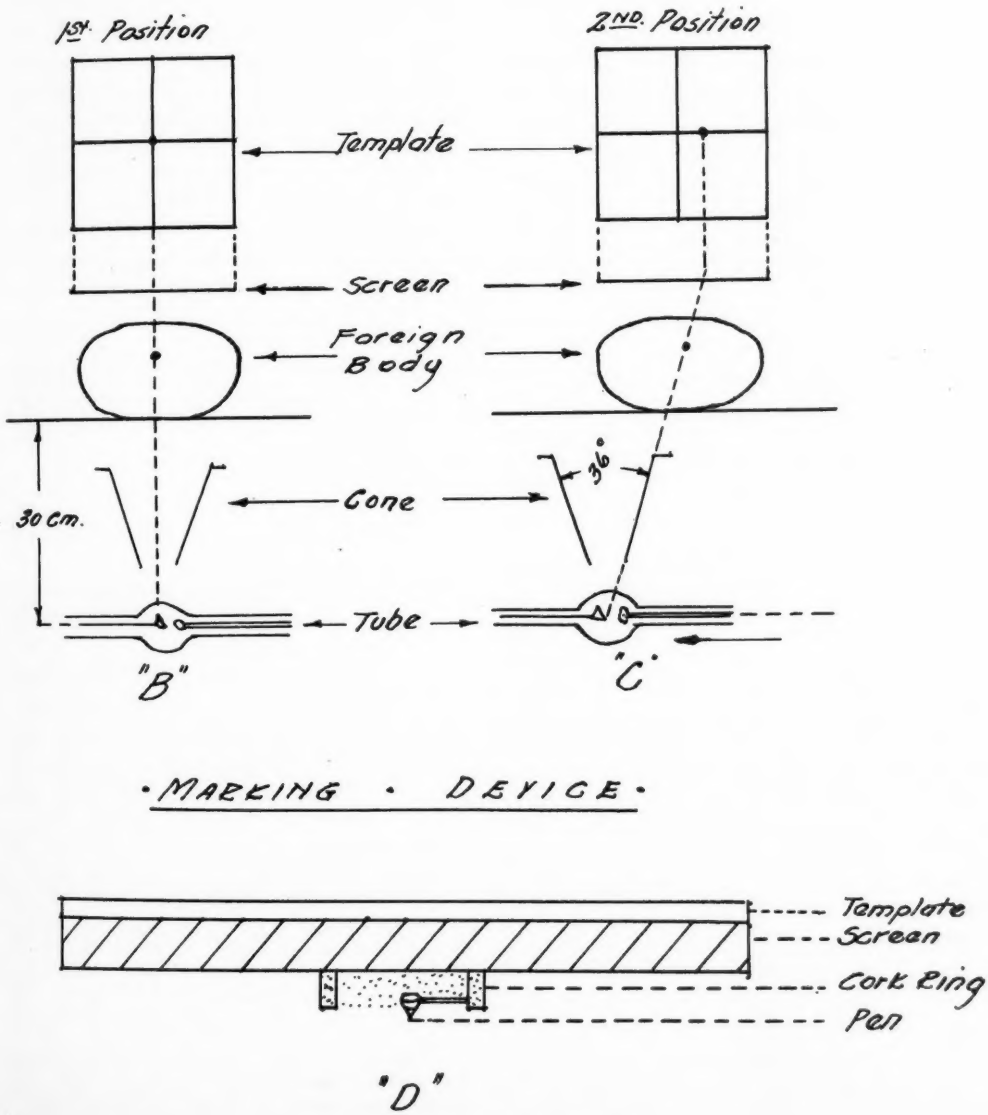


Fig. 3. The localizing profondoscope.

(*H*) Note negative findings as: free from projectiles, not free from wounds.

THE LOCALIZING PROFONDOSCOPE

(*A*) Apparatus.

1. A transparent template 25 cm. square. (Best material $^1/_8$ in. thick lucite—Du Pont, diagram A).

   Directions for rule:

   (*a*) Find exact center by cross-hairs from the corners.

   (*b*) Inscribe cross-lines vertically and horizontally and center point.

   (*c*) With dividers inscribe concentric arcs on each cross-quadrant line $^1/_3$ cm. apart, beginning at a point on the cross-quadrant line equal to the vertical measurement of the marking device from its tip to the top of the screen.

   (*d*) Place on fluoroscope screen.

2. The X-ray Equipment.

   A fluoroscope with the tube mounted beneath the table, screen above. The anode of the tube must be exactly 30 cm. from the table top (Diagram B).

3. A special cone must be attached to the fluoroscopic head, the base of which will form an angle of 36 degrees, with the apex at the anode (Diagram B). This angle is of the utmost importance.

   This special cone must be accurately centered above the tube so that the apex of the cone angle is exactly placed at the focal spot of the tube. The reason for this is the extreme importance of the relation between the template markings and the cone angle ratio.

4. Marker insert beneath screen. A piece of cork in the form of a rectangular ring (measurements with a skin pen suspended inside) is placed beneath the center of the insert and screen (Diagram D).

   The marking on the insert is calibrated to allow for this extra depth.

(*B*) Method.

1. Find the foreign body and localize preliminarily to near the center of the screen.
2. Close the fluoroscopic shutter to its smallest opening, exactly aligning the intersection of the cross-quadrant lines, the foreign body, and the anode of the tube in a vertical plane.
3. Shift the tube off-center until the center of the foreign body shadow on the screen goes outside the field of visual illumination caused by the cone on the tube head (Diagram C).
4. The actual depth of the foreign body in centimeters is the figure on the insert where the edge of the visual field intersects the shadow of the foreign body.
5. All reading on this insert is actual depth from the surface of the skin to the foreign body and not from the screen.

CONCLUSIONS

1. A review of the subject of foreign body localization is made.
2. The procedure recommended by the Surgeon General's Office, U. S. Army, is outlined.
3. A new method (the Localizing Profundoscope) of extreme simplicity and accuracy, which can be used under any circumstances where x-rays are available is offered.

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* No attempt has been made to include in this the many fine articles written in languages other than English.

In compiling this work an attempt has been made to find all English references; some, however, have probably escaped us. It will be deeply appreciated if the reader will notify us of any reference inadvertently passed over so that the record may be made complete.

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A ROENTGEN PELVIMETER SIMPLIFYING THOMS' METHOD

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SOON after the discovery of the x-ray by Roentgen in 1895 one of the practical uses first thought of was the exact measurement of the pelvic inlet for obstetrics. Because of the divergence of the rays and the subsequent enlargement of the image on the radiograph, methods for compensation were devised before 1900. One of the simplest of these consisted of a string belt of lead beads 1 cm. apart, which was worn by the patient around the pelvis so that it lay in the plane of the superior strait. The distance on the radiograph between the images of adjacent lead pellets then represented 1 cm. in the superior strait. Keeping this factor in mind, any measurement of the inlet could be calculated.

Herbert Thoms (2), of America, has improved on this idea and over the last twenty years has developed the scale or grid method. This consists essentially of radiographing the pelvic inlet as nearly parallel to the film as possible and then the patient is removed and an opaque perforated plate, with small holes at centimeter intervals, is placed in the plane of the superior strait. A second short exposure is then given with tube and film in the same position as at first. The rays which penetrate the small holes print black dots on the previously exposed film.

Because of the distortion this distance between neighboring dots is more than 1 cm. and may be 1.5 cm., but it represents actually 1 cm. in the pelvic image; by counting the spaces anteroposteriorly and laterally across the pelvic inlet the exact measurement, within small limits, is read without any calculation (3).

The clinical value of the method lies in its presentation of most of the essential factors in the obstetric study of the pelvis (first), direct actual measurements of all diameters of the inlet (second), and this is almost as important as the first, the contour of the pelvic inlet. Caldwell and Moloy say, "The absolute pelvic type depends on the shape of the inlet." This second finding gives information invaluable in prognosis and in relation to the recent trend to classify the female pelves into essentially the four groups (*a*) gynecoid, (*b*) anthropoid, (*c*) android, and (*d*) platypelloid, of which the modern exponents are Caldwell and Moloy (4), Thoms, and others.

This method has been endorsed by many scientific students of pelvimetry as accurate and reliable (3). However, its widespread adoption has been hindered by the difficulty of fixing in space the plane of the superior strait, a procedure which is necessary. In the Thoms method a plumb bob is hung to mark that of the symphysis pubis and after the patient is off the table the perforated plate is placed in the proper plane by measuring the distance and height of the opposite end of the external conjugate (Baudelocque diameter). This must be done accurately and it requires considerable time by an expert.

The device herein described and illustrated simplifies the method to such an extent that any technician may learn quickly to complete the total process within ten minutes. It consists essentially of a portable platform to fit the surface of the x-ray machine (Fig. 1). From the middle of the platform at about a 45°

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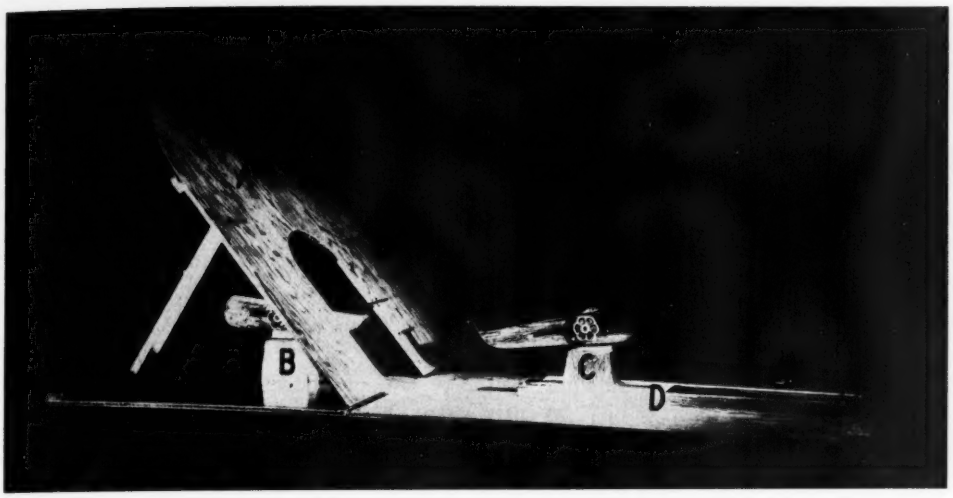

Fig. 1. Sectional photograph of roentgen pelvimeter. *A*, backrest with device to alter the angle; *B*, posterior post fixed to platform; *C*, anterior post mounted on a sliding plane, *D*, so that after adjusting the movable arm the post can be temporarily moved away so that the patient may get off the table. After she has been roentgenographed the post is shifted back into place and the two cross-arms then mark in space the plane of the superior strait. The perforated plate is laid over them and the second exposure made.

angle rises a backrest with an opening in the lower central portion. To the rear of the backrest a post is fixed to the platform base and from this rises a movable arm with a 5-inch transverse marker. This marker may be fixed in an arbitrary position at the posterior end of the patient's external conjugate—at the space between the fourth and fifth vertebral spines. On the front of the platform for marking the point at the anterior end of the external conjugate (1 cm. below the top of the symphysis pubis) is a post on a sliding frame. This also has a similar arm with a narrower transverse marker which, when the post is as near the patient as it will slide, is fixed against the patient 1 cm. below the top of the symphysis pubis.

With the patient sitting on the platform, leaning against the backrest and the markers fixed, posterior one at 4–5 lumbar space, anterior one 1 cm. below the top of the symphysis pubis, the film is exposed. For non-pregnant women we have found the following technic satisfactory: Bucky diaphragm, 36 in. tube-cassette distance, 80 kv., 15 milliamperes, 15–25 seconds' exposure. For full-term pregnant cases, same setting, 20–35 seconds' exposure. It greatly improves the roentgenogram if the cathode is toward the patient's head, the tube parallel with her body, and the anode toward her feet. Otherwise the promontory half of the film is likely to be underexposed. Inasmuch as the patient is fixed by this device with regard to the position of the pelvic inlet, a very small film (we use routinely 8 × 10) may be used.

After the exposure of the patient is made, the sliding post is shifted forward without loosening the fixed arm marker. This allows room for the patient to climb off the table, after which the sliding post is pushed back to the position of the first exposure. Now, with the tube and film in the same position the lead plate (its central area is perforated with a small hole every centimeter in both directions) is placed to lie across the two fixed markers. (*Note:* If the pelvis is tilted the method is still accurate because the lead plate is equally tilted.) A second flash exposure, of one-twentieth of a second, is then made, printing the dots over the previously exposed film. Counting the spaces between

dots anteroposteriorly and transversally gives directly the two diameters in centimeters.

Outline of the pelvic inlet indicates the type of pelvis. If the anteroposterior is less than the transverse, gynecoid; if the anteroposterior is equal to or slightly greater than the transverse, anthropoid; if the opening is roughly triangular, android; if there is marked flatness, platypelloid (4). If the physician is not satisfied from the single film as above, he may have further study made of the sacral contour and of the outlet including the lateral film which Thoms has recently advocated. However, we have not found further x-ray study to be of any great value but have been very well satisfied with a single 8×10 film in the study of the pelvis of the doubtful cases of 1,600 pregnancies and deliveries in the last two years in which this device has been in use. As suggested by Caldwell and Moloy, we rely upon palpation of the sacrum and the width of the subpubic angle for additional facts, and these should be part of the information to be sought in every rectal or vaginal examination.

The outstanding finding has been the large percentage of patients, both colored and white, with normal or essentially normal pelves. We have found that practically all patients with more than 9 cm. true conjugate diameter will deliver spontaneously or with low forceps. Among 2,000 women we have found only five or six with anteroposterior diameters less than 9.5 and one of these was a dwarf and one a case of traumatic scoliosis. We are of the opinion that such a roentgenogram of every patient whose ability to deliver, even after labor is in progress, is questioned would be of greatest value in reducing the prevalent high incidence of cesarean section based on erroneous diagnosis of contracted pelvis.

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EXCRETORY UROGRAPHY BY THE INTRAMUSCULAR INJECTION OF DIODRAST

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EXCRETORY urography, by way of intravenous administration of diodrast (Winthrop), hippuran (Mallinckrodt), or neo-iopax (Schering), is well established. It is receiving increased use by the roentgenologist, internist, pediatrician, general practitioner, and urologist. The usefulness of excretory urography can be extended by making the procedure available in cases in which intravenous administration is difficult or impractical; such as in infants and children, or in adults with buried or blocked veins.

Diodrast (Winthrop), a 35 per cent solution of iopyracil, has been administered intramuscularly at the University of Nebraska and Nebraska Methodist Hospitals in a series of 18 patients, 10 of whom were children. Good visualization of renal pelves, calices, and ureters, almost equal to the concentration seen following intravenous administration, resulted in nearly all cases. No complications or untoward results have been noted in any patients.

HISTORY

Von Lichtenberg and Swick (14), in 1929, were the first to make excretory urography a practical procedure by intravenous injection of uroselectan. Butzengeiger (3), in 1931, used skiodan subcutaneously. He injected 20 grams of the drug in a 500 c.c. solution into each axilla as a hypodermoclysis. A report was made on 30 cases which showed this procedure to be almost as satisfactory as intravenous injection. The patients suffered no local reaction or sloughing and experienced only the discomfort of the actual administration of the skiodan. Hillebrand (5), in 1932, gave skiodan subcutaneously to children. He used 100 c.c. of a 4 per cent solution and the visualization was highly satisfactory. Swick (12), 1933, reported diagnostic urograms two hours after ingestion of 15 grams of hippuran in syrup, although in our experience visualization has been entirely inadequate by this method. Beer and Theodore (1), 1934, gave neoskiodan by hypodermoclysis to 15 patients, 10 of whom were children. Fairly satisfactory shadows were obtained from 50 to 60 minutes after administration of the drug. Senger and Ruggiero (10), 1936, reported diagnostic excretory urograms following subcutaneous injection of 10 per cent skiodan. Dreyfus and also Perman and Lichtenstein (9) used 7.5 per cent perabrodil subcutaneously with good results. Travis (13), 1937, obtained good urograms with no untoward results following subcutaneous injection of 80 c.c. of 9 per cent diodrast in 18 children between the ages of three weeks and nine years.

Our procedure has differed from those previously used, in two particulars: (1) the diodrast was used in 35 per cent solution in all cases instead of in an isotonic solution; (2) the solution of diodrast was injected intramuscularly into the gluteal region instead of subcutaneously. No superiority of roentgenograms is claimed for these innovations although the procedure is safe and can be rapidly and conveniently executed. We wish to emphasize that we are not recommending the intramuscular injection of any of the various excretable radiopaque drugs other than diodrast.

MERITS OF EXCRETORY UROGRAPHY

The pediatrician and the child have benefited greatly from excretory urography (Campbell, 4, Hyman, 6, Perman and Lichtenstein, 9). Retrograde pyelography is difficult in male infants and at times it may be impractical to pass a cystoscope through the small urethra. At least, it is taxing and not without danger to the pa-

tient. A general anesthetic is usually necessary, introducing the possibility of complicating sequelæ. Roentgenograms made during general anesthesia are blurred by breathing and often unsatisfactory. Added expense is incurred due to the desirability of hospitalization.

Excretory urography in children is of great value in the case with recurrent infection along the urinary tract, persistent pyuria, or an obscure fever of unexplained origin. Recurrent pyelitis is usually due to some developmental abnormality in the urinary tract or other mechanical interference with the passage of urine from the kidneys or bladder. Excretory urography is of great value in these cases for two reasons: (1) congenital anomalies are often shown which might not be demonstrated by retrograde pyelography; (2) the extent of the functional and structural impairment of the kidney is well demonstrated. Abdominal tumors in children are frequently renal in origin and urography is most helpful in the determination of the site of origin and the extent of the lesion. Too frequently no pyelographic or urographic x-ray studies are made in children with recurrent pyelitis because cystoscopy is a dreaded procedure and intravenous administration of excretable contrast solutions is difficult or impractical. The intramuscular use of diodrast provides a safe and practical method for demonstration of the renal pelves and calices without regard for the uncertainties of venepuncture in children.

The urologist frequently encounters problems in which excretory urography is essential or advisable. Passage of the cystoscope may be impractical due to stricture or narrowing of the urethra. In some cases the expert cystoscopist is unable to pass a catheter up one ureter due to obscuration of its orifice at the bladder or obstruction of the ureter itself. Two kidneys and double or branched ureters occasionally occur, in which case the retrograde catheter enters only one branch of the ureter with only partial visualization in the pyelogram. In the above cases an excretory urogram will show valuable information which cannot be provided by the retrograde pyelogram. Supposed rupture of a kidney makes excretory urography preferable to retrograde pyelography due to reduced possibility of infection, minimum shock, and speeding of information.

LIMITATIONS OF EXCRETORY UROGRAPHY

The limitations of excretory urography are well established. The procedure is of little or no value to the patient who shows grossly impaired renal function, or in whom fine delineation of pyelographic detail is essential for differential diagnosis, such as in early tuberculosis or questionable neoplasm. It is contra-indicated in cases of severe liver damage, advanced nephritis, and uremia. It must be used with care in tuberculosis and hyperthyroidism. Renal function can be impaired by pyelonephritis, congenital polycystic disease, obstruction, nephritis, or reflex inhibition of excretion. In case the excretion of phenolsulphonphthalein is under 10 per cent (normal 65 per cent), in two hours excretory urograms will be unsatisfactory by any method. Cases with moderate impairment of renal function may show some visualization after one to two hours. A dilated renal pelvis requires a longer interval, one to four hours, to accumulate sufficient iodide for visualization. The interval spacing of films must be correlated with renal function and with the clinical problem, if satisfactory excretory urograms are to be obtained.

TECHNICAL PROCEDURES

Clear demonstration of renal pelves, calices, and ureters by excretory urography demands maximum concentration of iodide, freedom from overlaying gas, retention of excreted iodide in pelves and ureters, brilliant contrast, complete immobilization, and sharp definition. Thorough preparation of the patient and the best roentgenographic technic are therefore absolutely

essential. The urographic concentration of diodrast obtained by the intramuscular route is about 80 per cent of that resulting from the intravenous route. Concentration of iodide can be somewhat increased by dehydration from withholding food and drink during the previous twelve hours (Berger, 2). On the other hand, in urgent cases, satisfactory concentration is usually seen without this preliminary dehydration.

Obscuring intestinal shadows can be reduced by catharsis, enemas, and pitressin. The bowel can be cleansed of feces by castor oil, one to two ounces, given 12 hours previously. In more urgent cases a tap water enema of two quarts is given 20 minutes before roentgenography. This is followed immediately by 0.5 c.c. to 1 c.c. of pitressin before evacuation (Kenning and Lofstrom, 7), unless contra-indicated by cardiac decompensation, coronary disease, hypertension, complete intestinal obstruction, or pregnancy near term. The gas-expelling effect of the pitressin begins to wane after about 15 to 30 minutes. A preliminary "scout" film is always essential and it will show opaque calculi and the amount of residual gas. A pillow under the knees will often allow the lumbar curve to drop down nearer the film and improve detail. Injection of diodrast always provokes a further accumulation of gas after from 10 to 20 minutes, apparently due to lessened bowel tone. In case the gas becomes troublesome, it can be decreased in evidence by a further 0.5 to 1.0 c.c. of pitressin. A mild hypnotic such as phenol-barbital (Perman and Lichtenstein, 9) aids the procedure by quieting the patient and reducing his discomfort during the prolonged, tedious examination.

Intramuscular injection of diodrast should be limited to cases in which intravenous administration is impractical due to small buried or blocked veins, or to an unco-operative, restless patient. The sterile tray for intramuscular injection carries a 2 c.c. syringe; a 26 gauge hypodermic needle; a 20 c.c. syringe; a 16 gauge needle for filling the syringe; two 23 gauge 2-inch infiltration needles with safety shank used for intramuscular injection; a medicine glass; 2 per cent novocaine without adrenalin; 70 per cent alcohol, sponges, and diodrast. A flask of sterile distilled water should be at hand to allow dilution of diodrast to half strength in case the physician prefers a less hypertonic injection. A small cutaneous novocaine wheal is made in the upper outer quadrant of each buttock. The intramuscular needle is then directed superiorly and laterally into the gluteal region to avoid the sciatic nerve. The point of the needle is occasionally shifted slightly during the injection of diodrast to promote diffusion. The total quantity injected is from 10 to 20 c.c. in children, and from 20 to 30 c.c. in adults, divided between the right and left buttocks. In some cases we have drawn 1 c.c. of novocaine into the diodrast with relief of all discomfort during and following injection. Adrenalin in the novocaine would retard absorption by vasoconstriction. We have endeavored to hasten absorption in some cases by application of a hot water bottle to the buttocks.

Compression of the bladder and lower ureters improves visualization of renal pelves and calices (Kornblum, 8, Berger, 2) due to distention of the upper urinary tract by the retained iodized urine. Latent pyelectatic changes can be made apparent which would not be demonstrated without pressure and anatomic details are shown with more clarity. Urine in the bladder is no handicap in excretory pyelography and may aid by increasing ureteral back pressure. Compression also improves urograms by better immobilization and lessening of cardiovascular pulsations and other involuntary movements. The compression bag used by us is a 5-inch inflatable bag supplied by Picker with his gastro-intestinal compression belt. The collapsed bag is placed directly above the symphysis and a table compression band snugly drawn over it. The bag is then inflated to tolerance, being certain that it rides in the pelvis between the symphysis and sacral promontory. Pressure is usually applied directly following the first

urogram and kept in position until after the second urogram is exposed. In case particular attention is being directed to the lower ureters, the urogram should be made directly following release of the pressure.

renal pelves. Absorption can be evaluated in the roentgenogram since the intragluteal diodrast is clearly demonstrated, as in Figs. 1-*A*–*C*. About 95 per cent of the diodrast is absorbed after two hours. An

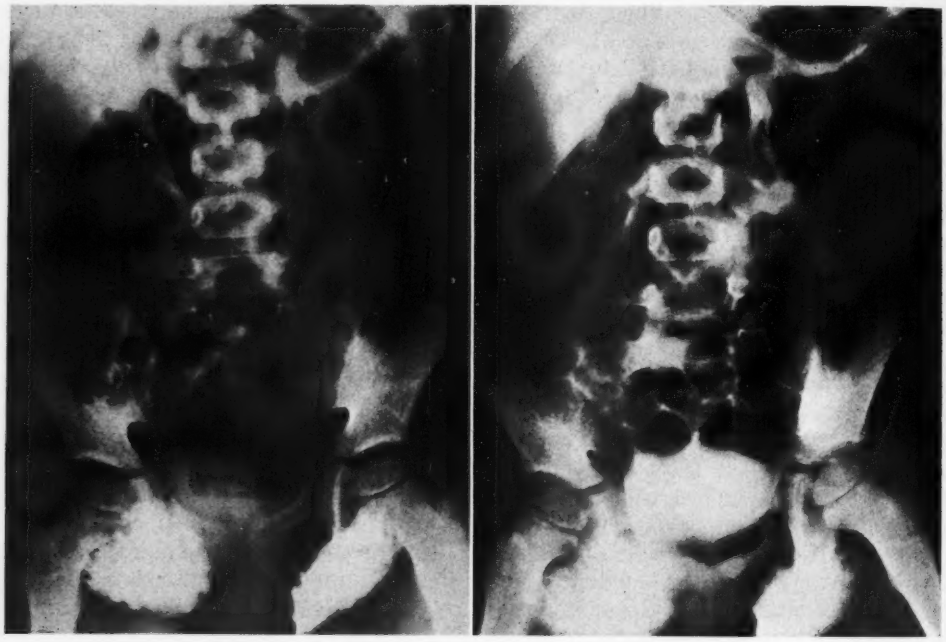


Fig. 1-*A*. Fig. 1-*B*.

Fig. 1-*A*. Case 1. Ten minutes following injection of 9 c.c. of diodrast into each gluteal region, showing good excretion by each kidney. Bowel was poorly prepared, no pitressin used.
Fig. 1-*B*. Case 1. Thirty minutes following intragluteal injection of diodrast, good concentration. Gross dilation of right renal pelvis with caliectasis. Normal left renal pelvis.

Optimum contrast and detail should be approached in the roentgenograms by relatively low kilovoltage, small diaphragm, Potter-Bucky grid, high milliamperage, short exposure time, adequate distance, and small focal spot.

The first roentgenogram following intramuscular injection can be made after an interval of ten minutes as a test of renal function. Excretion is sometimes evident within five minutes. Structural details are usually best shown with compression 30 to 45 minutes following intramuscular injection, depending on the rate of absorption, renal function, and capacity of

inadequate visualization after 60 minutes suggests impaired function or a dilated pelvis. Size and contour of the kidneys may be accentuated by the diodrast even though pelves and calices are not discerned. Lack of concentration after two hours usually indicates gross impairment of renal function. We have checked some cases showing inadequate visualization following intramuscular injection of diodrast with parallel findings. In general one can roughly estimate the optimum time for the final urogram from the density of concentration prevailing in the ten-minute urogram.

CASE REPORTS

The general adequacy of the method is suggested by the variety of lesions demonstrated. Our small series has included Wilms' tumors, ureteral obstruction, aberrant polar vessels, double ureters and other congenital abnormalities, as well as essentially normal urinary tracts. The first case shows progressive absorption of diodrast from muscles and rate of excretion in urine. It also shows the utility of intramuscular injection after failure of intravenous injection and frustration of retrograde pyelography.

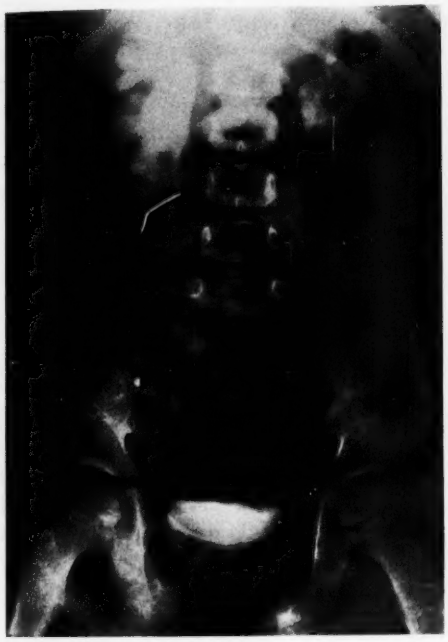


Fig. 1-*C*. Case 1. Two hours following intragluteal injection of diodrast, nearly complete absorption from glutei with persistent clear visualization. Note constriction at right ureteropelvic junction.

Case 1. K. B., female, 5 years of age, was referred to the Nebraska Methodist Hospital, Nov. 6, 1936, by J. A. Henske, M.D., with a history of recurrent frequency, dysuria, pyuria and septic temperature for three months. An intravenous injection of diodrast was successfully

Fig. 2 (*above*). Case 2. Bilateral double ureters and kidneys. Slight caliectasis of right inferior kidney with dilation of its ureter. Urogram, 45 minutes following intragluteal injection of 20 c.c. of diodrast.

Fig. 3 (*below*). Case 3. Age 18 months. Ligation of right ureter during panhysterectomy for carcinoma of uterus. Urogram, 30 minutes after intragluteal injection of 20 c.c. of diodrast.

started but was interrupted by dislodgment of the needle after 2 c.c. The remaining 18 c.c. of 35 per cent diodrast was injected deeply into the right and left gluteal regions. There was a mild stinging pain such as accompanies any voluminous injection but no residual pain, tenderness, or damage of tissue was noted at any time by careful examination.

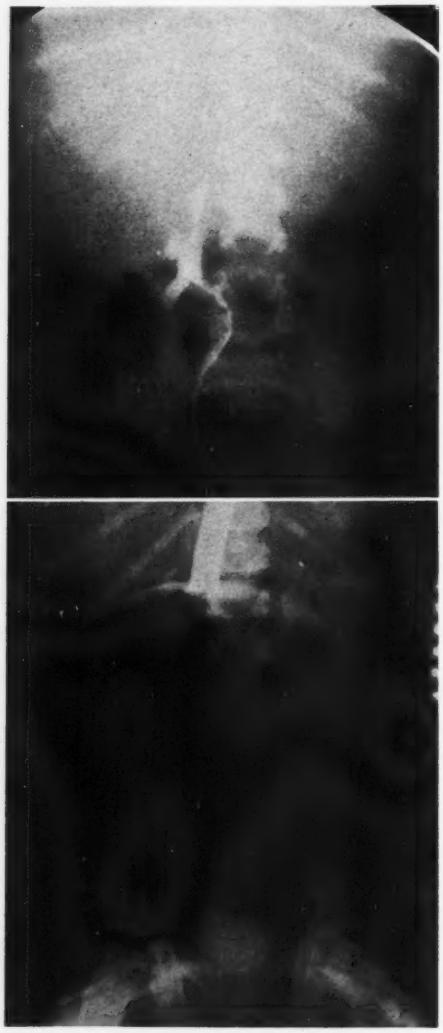


Fig. 4-*A* (*above*). Case 4. Large Wilms' tumor arising in superior lateral aspect of right kidney producing inferior displacement, with elongation and lateral compression of renal pelvis. Retrograde pyelogram.

Fig. 4-*B* (*below*). Case 4. Same Wilms' tumor, three months following x-ray therapy. Note recession of mass and relatively normal position and contour of right renal pelvis. Intramuscular excretory urogram at 30 minutes; compare with retrograde pyelogram, Fig. 4-*A*.

Serial roentgenograms made after 10 minutes, 30 minutes, and after two hours show progressive absorption and sustained, concentrated urinary excretion of diodrast as shown in Figs. 1-*A*–*C*. The right kidney was five to six times the normal size with dilation of calices, pelvis, and ureter. There was definite constriction at the ureteropelvic junction. Catheterization of right ureter was prevented by obstruction. Nephrectomy was done by Edwin Davis, M.D., for intractable pyelitis, with uneventful convalescence.

The patient with mild to severe recurrent pyelitis deserves a urographic examination. Pyelitis commonly results from some interference with urinary drainage as in the above case. Double or branched ureters are frequently associated with some zone of ureteral stenosis which may lead to stasis, infection, pyelectasis, and ureterectasis as in the preceding and following cases.

Case 2. C. M. H., female, 6 years of age, admitted to the Nebraska Methodist Hospital, Nov. 11, 1937, seen with a known history of four severe attacks of pyelitis since 15 months of age, each attack lasting from 10 to 14 days with septic fever to 106° F. Following novocaine anesthesia of skin, 10 c.c. of 35 per cent diodrast containing 0.1 per cent novocaine was injected into each gluteal region with practically no pain and with no subsequent soreness. A cleansing enema and 1 c.c. pitressin were given subsequently to reduce gas.

Urographic studies made 45 minutes after injection showed bifurcation of each ureter in the region of the ureterovesical junction with associated double renal pelves. Right inferior caliectasis and ureterectasis became evident with ureteral compression (Fig. 2).

Complete obstruction of one ureter or a unilateral loss of renal function is readily demonstrated by intramuscular urography. The following case is worthy of note in it-

self, being a highly malignant carcinoma of the uterus in a baby 18 months of age.

Case 3. J. J., female, 18 months of age, referred to University Hospital, Dec. 28, 1937, by H. B. Hamilton, M.D., with history of increasing vaginal bleeding for six weeks due to a highly malignant carcinoma of the uterus, 5 cm. in diameter, filling the pelvis and invading the upper vagina. Treatment consisted of panhysterectomy followed by 1,800 mgm.-hr. of radium. In view of possible ligation of a ureter, 10 c.c. of 35 per cent diodrast was injected deeply into each gluteal region. A urogram after 30 minutes showed a normal left kidney and ureter (Fig. 3). The right kidney showed no function, indicating ligation of ureter in this case.

TABLE I

Drug	Amount	Volume	Concentration
Diodrast	7 gm.	20 c.c.	35 per cent
Hippuran	12 gm.	25 c.c.	50 per cent
Skiodan	20 gm.	50 c.c.	40 per cent
Neo-iopax	15 gm.	20 c.c.	75 per cent

Intramuscular excretory urography is usually adequate for the diagnosis of large renal tumors and provides a graphic check on the accomplishments of x-ray therapy in these cases. A small residual tumor may escape recognition even with retrograde pyelography.

Case 4. F. H., male, 3 years of age, admitted to University Hospital, April 10, 1937, with a history of loss of appetite, presented a tumor mass filling the entire right side of the abdomen. An excretory urogram showed elongation and lateral compression of the right renal pelvis. The pelvis was displaced inferiorly through 5 cm. by the 10 × 15 cm. soft tissue mass in the right upper quadrant. This distortion was confirmed by retrograde pyelography (Fig. 4-*A*). A check-up, intramuscular urogram, made three months following 2,000 roentgens anteriorly and posteriorly to the tumor, shows good renal function bilaterally, regression of the tumor and restoration of position and contour of the right pelvis to near normal (Fig. 4-*B*). Nephrectomy showed a residual degenerating embryonal carcino-sarcoma arising from the superior pole of the right kidney.

EXCRETORY RADIOPAQUE AGENTS

The apparent lack of any pain or tissue damage following the intramuscular injection of 10 c.c. of standard strength diodrast into each gluteal region has amazed us. In case anybody is skeptical of the intramuscular injection of a strongly hypertonic solution of 35 per cent, as used by us, the solution may be diluted. We believe absorption and excretion would be practically as effective with dilution to one-half or one-fourth the concentration provided for intravenous use. Recent experimental studies indicate that subcutaneous injection gives equally or more rapid absorption and no more reaction than intramuscular injection. Histological study showed a very slight transient or usually no reaction 24 hours after 35 per cent diodrast. Induration and foreign body reaction nearly always follow injection of 70 per cent diodrast. The reaction is less severe and of shorter duration after subcutaneous injection.

We have had no clinical experience with the intramuscular injection of any of the various other agents commonly employed for intravenous excretory urography: neo-iopax (Schering), skiodan (Winthrop), and hippuran (Mallinckrodt).

Diodrast possesses the advantages of the lowest concentration and the smallest volume with equivalent concentration. The excessive concentration of the standard preparations of these other agents made us fear severe pain, irritation, and possible sloughing although we have had no clinical experience with them. The chemical structure of these agents differs as shown by their formulæ and these differences may vary their biologic effects.

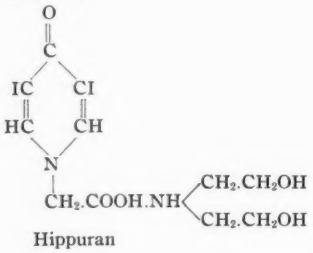
SUMMARY

1. Excretory urography by hypodermic or intramuscular injection of 35 per cent

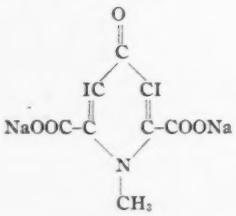
diodrast (Winthrop) has proven a safe and practical procedure in 18 patients, 10 of whom were children.

Skiodan

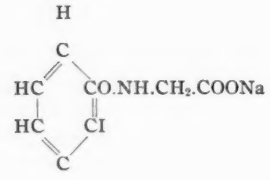
Diodrast



Neo-iopax



Hippuran



2. Its use should be limited to cases in which intravenous injection is impractical due to small buried or blocked veins or due to lack of co-operation by the patient. Subcutaneous urography is particularly valuable in small children.

3. Concentration of iodide by the extravascular route is about 80 to 90 per cent that by the intravenous route and the time required for optimum visualization is about twice as long.

4. No clinical evidence of immediate pain, residual soreness, or subsequent damage to tissue has been attributable to the concentrated solution of diodrast.

5. Satisfactory excretory urography demands adequate preparation of the patient, excellent roentgenographic technic, and correlation of roentgenography with renal function and the clinical problem.

6. The extra-vascular injection of undiluted neo-iopax, hippuran, and skiodan seems contra-indicated on the basis of excessive concentration and large volume of solution, although we have had no clinical experience with these other materials.

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PSEUDO-GASTRODUODENAL FISTULA

WITH REPORT OF ONE CASE[1]

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Veterans Administration Facility

GASTRODUODENAL fistula as a complication of gastric ulcer is rare. Monroe (12), in 1927, in a summary of the literature on fistula as a complication of gastric ulcer, found ten cases and added one of his own. Of these only two, his own and that of Casellas (2), had been recognized by roentgenology. Löw-Beer (8) refers to 12 cases, eight of which were on an ulcer basis, and adds one of his own. These 12 cases include six of those summarized by Monroe. Of the cases reviewed by Monroe and Löw-Beer, five, those of Casellas, Monroe, Berg, Haudek, and Löw-Beer, were recognized by roentgen examination.

Melchart (10) reports two cases and points out that these, and some of those reported in the literature, although having a roentgen appearance of gastroduodenal fistula, are not true fistulæ, but are due to contraction of the lesser curvature drawing the pylorus upward and to the left.

We have found reports of 11 cases, in addition to those mentioned by Monroe and Löw-Beer, which have been recognized by roentgen examination, making a total of 16 cases of true or pseudo-gastroduodenal fistula recognized by roentgenology. To these we add one case of our own.

PATHOLOGY

This condition is essentially a complication of chronic gastric ulcer. The pathologic process involved is discussed by Schinz (14), Löw-Beer (8), and Melchart (10). Chronic gastric ulcer is characterized by a higher degree of peri-ulcerus infiltration and connective tissue proliferation than is acute ulcer. In long-standing cases there may be diffuse serositis and infiltration of the longitudinal muscle fibers of the lesser curvature. Contraction of the resulting cicatricial tissue produces shortening of the lesser curvature. In the original fish-hook stomach, involvement of the hepatogastric ligament draws the pylorus and cap upward to the right; involvement of the hepato-duodenal ligament draws it up to the proximity of the ulcer. Further shortening of the lesser curvature and involvement of the circular muscle layer produces a bilocular stomach. The pylorus being drawn to the niche, the lower pole of the stomach has a tobacco-pouch appearance. The duodenum is elongated and drawn to the left, and the meal apparently passes into the duodenum through a fistula from the niche. Inability to find the pylorus in its usual location will suggest the true nature of the process.

A true fistula may form when the cap is drawn into the proximity of the niche but not actually into it, but with the cap and pylorus in such close proximity to the ulcer it may be impossible to demonstrate a fistula, even though it is present. This was true in Lüdin's case (9), where two openings, one the normal pylorus, the other a fistula between the ulcer and the cap, separated by a narrow bridge of tissue, were found at operation. The fixation of the pre-pyloric portion of the stomach high on the lesser curvature was recognized by roentgen examination, but the perforation was not.

In the long fish-hook stomach, where the cap lies normally in fairly close proximity to the lesser curvature, a penetrating ulcer might perforate into the superior duodenum, as suggested by Thierfelder (15), without marked shortening of the lesser curvature. This would be more apt to occur with simultaneous ulcers of the stom-

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ach and duodenum. Berg's case (1), in which the meal left the stomach through the pylorus and then ran back from the duodenum into the stomach, through a fistula, may have been one of this type.

Thierfelder's (15) case was diagnosed by necropsy and was similar to Lüdin's (9). The pylorus was high on the lesser curvature and Thierfelder suggested that the rarity of the condition might be accounted for by constitutional types. He apparently assumed that the fish-hook type of stomach was rare. His report was made almost thirty years before the roentgen ray made possible the study of the position of the normal stomach during life, and this assumption may have been in accord with the accepted anatomic belief of that time.

In the cases we have reviewed, the duration of ulcer symptoms has been given in eight, and varies from three years (3) to thirty-seven (10) and thirty-eight years (9). A definite ulcer of the lesser curvature had been demonstrated on roentgen examination in five cases, from one month (5) to eight years (10) before the fistulous appearance was found.

ROENTGEN FINDINGS

For the diagnosis of true gastroduodenal fistula it is necessary to demonstrate a passage through the normal pylorus and a separate passage through the fistula, or a retrograde filling of the duodenum proximal to the fistulous opening. On the other hand, inability to demonstrate the pylorus and cap, apart from the fistula, does not necessarily refute the presence of the latter, as in neither Moiroud's case (11) nor in that of Lüdin (9) could it be found, although a fistula was found in each case, at autopsy in the former, and at operation in the latter. In such cases a fistula cannot be proved to exist by roentgen examination alone.

In pseudo-gastroduodenal fistula the opaque meal passes directly into the duodenum high on the lesser curvature and no pyloric opening can be found lower in the stomach. In addition, there is usually a bilocular or tobacco-pouch stomach with retention in the lower pole. In three of the 11 cases found in the literature (3, 7, and 13), bilocular stomach is not mentioned; in two (7 and 8), retention is not mentioned. In Monroe's case (12) there was no retention at the time of the last examination, probably because of the gastrojejunostomy opening in the lower pouch. With these exceptions, bilocular stomach and retention were present in every case.

In addition, there may be increased or decreased peristalsis, increased secretion, gastrospasm, atony, or dilatation. Frequently the lower pole of the stomach empties only when lifted upward. Rigidity and shortening of the lesser curvature are always present, and the entire stomach is usually to the left of the mid-line.

SUMMARY OF REPORTED CASES

Moiroud (11) reports a case in which a fistulous communication between the stomach and duodenum at the duodeno-jejunal junction was found at autopsy. On roentgen examination the meal was observed to appear in the jejunum without passing through the pylorus and duodenum. In Lüdin's case (9) the stomach was vertical and bilocular, the barium ran downward to the right from the lesser curvature above the lower pole. At operation, the pyloric portion was found to be a dilated pouch. The anterior face of the lesser curvature was fixed by scars to the duodenum, with marked shortening of the lesser curvature. The pylorus communicated with the duodenum through two openings, separated by a narrow bridge of tissue: the lower of these openings was the pylorus.

In three cases, those of Berg (1), Haudek (6), and Casellas (2), the diagnosis was made by roentgen examination, unconfirmed by operative or necropsy findings. Nevertheless, a diagnosis of true fistula is justified in each case. In Berg's case the meal was expressed from a dilated lower pouch through the pylorus but ran back into the stomach through a fistula from a penetrating ulcer on the lesser curvature. The appearance of the stomach in his

illustration is quite similar to that of pseudo-fistula, except that the pylorus can be distinguished as separate from the fistula. Haudek's case, reported by Löw-Beer, shows a fistulous tract from the middle of the lesser curvature to the duodenal cap. At the same time the pylorus is seen. There is no noticeable shortening of the lesser curvature. Casellas reports a case in which two openings from the stomach to the small intestine could be demonstrated, the pylorus in normal position, and an opening from the upper pouch of the stomach into the jejunum or terminal duodenum.

No other reports of true gastroduodenal fistula, proved by either operation or autopsy, have been found, although 11 other cases which have the roentgen appearance of gastroduodenal fistula have been reported. In these cases it has been proved, by autopsy in one case, and by operation in five others, that no fistula was present. In two others (3 and 12) an operation was performed before the roentgen diagnosis, and in each case the surgeon made a diagnosis of inoperable gastric carcinoma, since disproved in each instance.

Melchart (10) reports a case which came to autopsy in which a large ulcer scar of the pars pylorus extended from the anterior to the posterior surface of the lesser curvature. There was kinking of the lesser curvature. The cardia and the pylorus were drawn toward each other into the scar. There was no fistula. Roentgen examination revealed a bilocular stomach from which the meal entered the duodenum through the middle of the lesser curvature. The lower pole was still filled at 24 hours. Similar roentgenological findings were present in six cases (4, 7, 12, 13, and 14, 2 cases) in which no fistula was found at operation, but all showed serositis and shortening of the lesser curvature with high displacement of the duodenal bulb. The length of the lesser curvature was stated to be 4 or 5 cm. in one case (4), and the breadth of three fingers in another (13).

Curiously enough, in the two cases (3 and 14) in which laparotomy was performed previous to the roentgen examination at which the diagnosis of fistula was made, the operating surgeon made the diagnosis of inoperable gastric carcinoma because of the indurated lesser curvature and indurated masses in the lesser omentum or liver. In Monroe's case (12) a later roentgen diagnosis of gastric ulcer was made. At this time the stomach was atonic and divided into two pouches by an incisura on the greater curvature. On the lesser curvature, opposite the incisura, was a projection near which the barium was seen to pass apparently into the small intestine. The sphincter duodenum and the antrum were not seen. There was a 24-hour retention. At operation, a mass due to induration of the lesser curvature and fading away in all directions was found. The pylorus was drawn up and to the left to the under surface of the left lobe of the liver to which the entire lesser curvature was adherent. No carcinoma or metastasis was found and no mention is made of a fistula. An ulcer of the lesser curvature, which had perforated but which was prevented from extravasation by adhesions, was found. A posterior gastro-enterostomy opening was made. Roentgen examination seven years later revealed much the same findings, although the stomach was now hypertonic and there was a gastro-enterostomy opening in the lower pouch which was functioning—thus there was no retention at six hours. The duodenal cap could not be identified. At this time the impression was: "Gastric ulcer, hour-glass stomach, gastroduodenostomy (probably spontaneous), gastrojejunostomy." In view of the resemblance of this case to those reported since that time, in which no fistula was found, as well as the fact that the differences in appearance between the first and second examinations can be explained by the gastro-enterostomy, it seems probable that this is a case of pseudo-fistula, as no fistula apart from the pylorus was demonstrated. As surgery was not indicated at the time of the last examination, no operative check on this finding was possible.

In Cato's case (3) there was also a roentgen diagnosis of gastric ulcer before operation, and at 17 months after the operation the crater had increased in size and the pylorus and pyloric segment of the duodenum were drawn up on the lesser curvature adjacent to the ulcer, so that the second portion of the duodenum occupied the normal position of the cap. Five months later, on another roentgen examination, the meal passed through the ulcer directly into the first portion of the duodenum. No meal could be forced through the pylorus. There was a 40 per cent, five-hour residue. Cato reported this as a fistula, but as the pylorus could not be seen it was probably drawn into the ulcer, near which it was previously found. In favor of the diagnosis of fistula was the marked clinical improvement of the patient. This case was complicated by the presence of syphilis, and it is impossible to evaluate correctly the effect of antisyphilitic treatment on the clinical improvement or the rôle of the disease in the ulceration and induration of the stomach.

Löw-Beer (8) reports a case not confirmed by operation or autopsy. Gastroscopic examination showed the mucous folds to converge into the niche of a calloused ulcer with a definite rim. Regurgitation of the duodenal contents into the stomach was observed, and the thickened converging folds were seen to converge abruptly into the mucous membrane of the superior duodenum. On roentgen examination similar mucosal markings were seen. The mucosal relief of the pyloric portion was separated from that of the body by a narrow shadow which Löw-Beer thought to result from a fusion of the lesser curvature and the pyloric segment, with a fistula between the stomach and duodenum above it. However, since the pylorus or cap could not be demonstrated, it is probable, as Melchart (10) suggests, that this septum is the result of scar tissue below the displaced pylorus, the entire contracted lesser curvature being above the latter. The roentgen examination in this case, the second case of Melchart (10), and in that of Hautefeuille (5), which were proved by neither operation nor autopsy, was characteristic of pseudo-gastroduodenal fistula.

CASE REPORT

J. N., white male, aged 40, entered the hospital Nov. 12, 1936, for the treatment of gastric ulcer. He gave a history of stomach pains with vomiting, while in the Army in 1918. In 1923, after a roentgen examination, he was told he had chronic appendicitis and a "dropped stomach"; in 1924 a gastric ulcer was found. He had hematemesis in 1923, and again in 1928. At the time of the latter hemorrhage he was hospitalized for one month, and was put on a 21-day milk and cream diet.

A year later he had a sudden pain while eating spare-ribs and sauerkraut. He had to be helped to bed. His physician was called and told him that his ulcer had ruptured and that an operation was necessary. He refused operation or hospitalization and remained in bed for two weeks. After a short ambulant period he re-entered the hospital for three weeks and received the same treatment as on his previous admission. At this time, Aug. 22, 1929, roentgen examination showed a large, hypotonic, fish-hook stomach. There was an hour-glass deformity with a niche opposite this on the posterior wall of the lesser curvature. The duodenum was fixed but not tender. There appeared to be dilatation of the third portion of the duodenum and some delay in this region. There was a 40 per cent, six-hour residue, and a 20 per cent residue at 24 hours.

Since that time he has been hospitalized several times. In July, 1930, a roentgen examination showed a filling defect on the lesser curvature, with marked spasm. Gastric carcinoma was suspected. In December, 1930, a roentgen examination by a third physician showed the stomach mostly to the left of the spine. At this time the findings were apparently the same as in July, but additional statements were made that the pylorus and cap were not visual-

ized and that there was a large five-hour residue.

The patient first entered this hospital Oct. 19, 1934. The report of the roentgen examination of the stomach at that time indicated findings similar to those described above. The duodenum was described in more detail than previously: "It was with some difficulty that the bulb could be visualized; it appeared to lie posterior to the pars pylorica and did not fill completely at any time; meal passed rapidly through it and outlined the second, third, and fourth portions; the second portion gave the impression of elongation and took its course well over into the left half of the abdomen." The impression of the roentgenologist making this examination was that the findings were probably due to gastric neoplasm with possible encroachment upon the duodenum. He stated: "The process seems too extensive to be accounted for by marked scar formation or perigastric adhesions attendant upon gastric ulcer." Though this statement seems logical, it is to be remembered that two cases are reported in the literature in which on examination at laparotomy the process was so extensive that a diagnosis of inoperable carcinoma was made, and others with marked perigastric adhesions are reported.

At this time the patient weighed 147 pounds and was 72 inches in height. His red blood cell count was 4,980,000, his white cell count 10,000. The hemoglobin was 88 per cent; the Wassermann reaction was negative. Test meal showed total acidity 54, free HCl 40. No blood was found in the gastric contents. A final diagnosis of peptic ulcer was made. Operation was advised but refused. The patient was put on a modified Sippy diet and left the hospital 28 days after admission, much improved, and showing a gain of 15 pounds in weight.

The patient was re-admitted to this hospital Nov. 12, 1936. His pains were now most severe when the stomach was empty. He had no other complaint; did not vomit; had lost no weight. During the interval since his previous admission he had been hospitalized elsewhere and given a preparation of histidine monohydrochloride, with considerable relief. Nothing of significance was found on physical examination or on routine laboratory examinations. Nothing was obtained from the stomach on passage of a Rehfuss tube. Although there was no anemia, occult blood was found in the feces on two occasions.

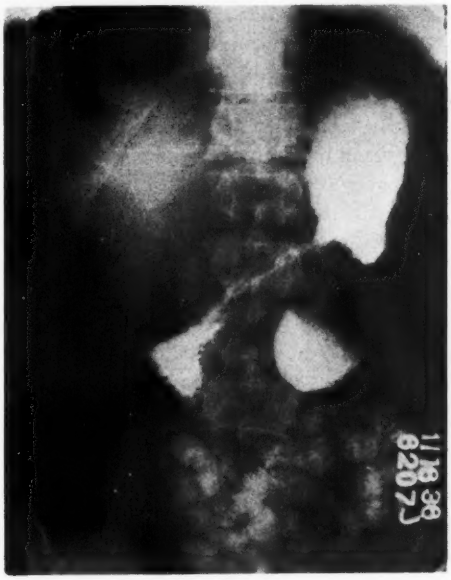

Fig. 1. Illustrating the course of the duodenum from the mid-portion of the lesser curvature, and the lower pouch of the stomach in which the pylorus cannot be found.

On roentgen examination the esophagus showed no abnormality. On reaching the pars media of the stomach, the barium stopped temporarily. At this point there was a large ulcer niche on the lesser curvature. Some of the meal then trickled into the lower portion of the stomach, which was dilated and formed a pouch. A deep incisura on the greater curvature produced a bilocular stomach. The entire stomach was to the left of the mid-line. A portion of the meal passed through the ulcer niche into the small intestine. At this time the impression received was that the meal passed into the duodenum near the duo-

deno-jejunal junction through a spontaneous gastro-enterostomy, although no retrograde filling of the duodenum was accomplished. The pylorus and cap were not distinguished, all the meal leaving the stomach through the opening on the lesser curvature. There was a 10 per cent, six-hour residue in the lower pouch, and a small amount of barium remained in it at 24 hours.

As the patient did not desire an operation, and showed improvement under medical treatment, he left the hospital Dec. 17, 1936, and no operative check on the condition was obtained.

A roentgen examination was made in the out-patient department Aug. 3, 1937. No change in the stomach was seen. The meal passed from the upper pouch into the lower as at the previous examination. That passing into the small intestine could be seen to pass into the superior duodenum, which was directed obliquely downward and to the right (Fig. 1). The descending duodenum was short and somewhat dilated, but there was no stasis in this area. The barium then curved upward and to the left to the jejunum behind the stomach. The pylorus could not be visualized on the lower portion. None of the barium could be seen to leave this portion, except that which could be expressed upward and through the niche. There was a 15 per cent, six-hour residue in the lower pouch, and a small amount was still present at 24 hours.

SUMMARY

A case of extensive periserositis of the gastric lesser curvature giving a roentgen appearance of gastroduodenal fistula is reported. Reports of 11 similar cases have been found in the literature, in eight of which no fistula was found at operation or autopsy. Reports of five cases of true gastroduodenal fistula, together with roentgenological findings, have been found.

Since the marked induration which is present may lead to a diagnosis of carcinoma, even at operation, it is essential that the roentgenologist familiarize himself with the history of the case. This condition occurs in patients with gastric symptoms of long standing, usually with a definite, previous diagnosis of gastric ulcer. If the possibility of this condition is kept in mind, and the patient's history taken into consideration, the correct diagnosis will be apparent.

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POSTMORTEM FINDINGS AND RADIO-ACTIVITY DETERMINATIONS FIVE YEARS AFTER INJECTION OF THOROTRAST

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RECENTLY there has been considerable discussion as to whether or not thorotrast should be used for visualization in radiography of the liver and spleen. Thorotrast contains "25 per cent by volume of thorium dioxide (19 per cent to 20 per cent by weight), about the same amount of protective colloid, said to be of a carbohydrate nature and further defined as a dextrin preparation. It contains as a preservative 0.15 per cent of methyl p-hydroxy benzoate" (1).

REPORT OF CASE

The patient, female, white, by occupation housewife, aged 73, was admitted to the Montefiore Hospital on May 18, 1937, with complaints of weakness, vertigo, palpitation, shortness of breath, a choking sensation in the chest, insomnia, anorexia, and nervousness. In 1932 she had been admitted to another institution for increasing weakness and loss of weight of five months' duration, together with anorexia, palpitation, and dyspnea on exertion. Five months before, she had had a three-day period of chills, fever, and malaise. On physical examination at that time, the spleen was palpable and the liver questionably enlarged. Seventy-five c.c. of thorotrast were injected intravenously in equally divided doses on June 16, 17, and 18, 1932. Hepatolienography showed slight enlargement of the spleen. Various liver function tests showed no abnormalities.

The patient was transferred to the Montefiore Hospital, where she was observed for ten weeks. Her liver enlargement disappeared, while the splenomegaly remained. She was in auricular fibrillation throughout the period of observation. She was considered to have atrophic cirrhosis with splenomegaly. The patient was discharged on a maintenance dose of digitalis and was not closely followed for five years.

On May 18, 1937, she was re-admitted with the complaints mentioned above.

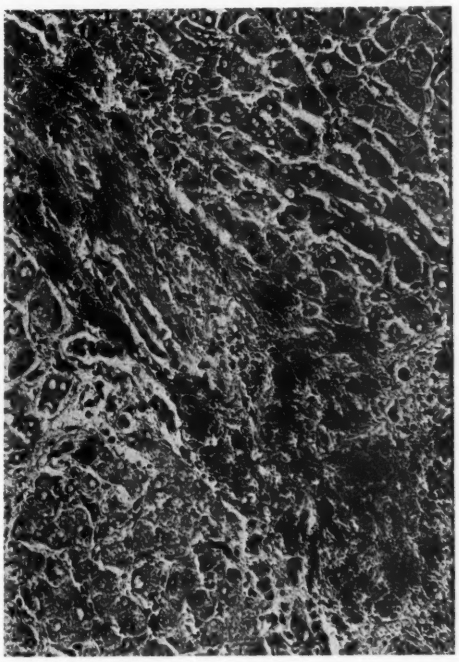

Fig. 1. Section of the liver showing portal fibrosis and collections of thorium in the portal canals. Occasional reticulo-endothelial cells in the sinusoids contain thorium. Hematoxylin and eosin stain (× 240).

The liver was barely palpable and the spleen was moderately enlarged. Examination of the heart, clinically and electrocardiographically, disclosed auricular fibrillation. The liver function tests were normal. There was a moderate secondary anemia. The total plasma proteins were 7.3 gm. per cent, with albumin of 2.4 and globulin of

4.9. The Wassermann and Kahn tests, as in the past on each hospital admission, were negative. On June 9, 1937, three weeks after admission, both lower extremities suddenly became very dusky, no pulses could be felt in them, and death ensued in a few hours.

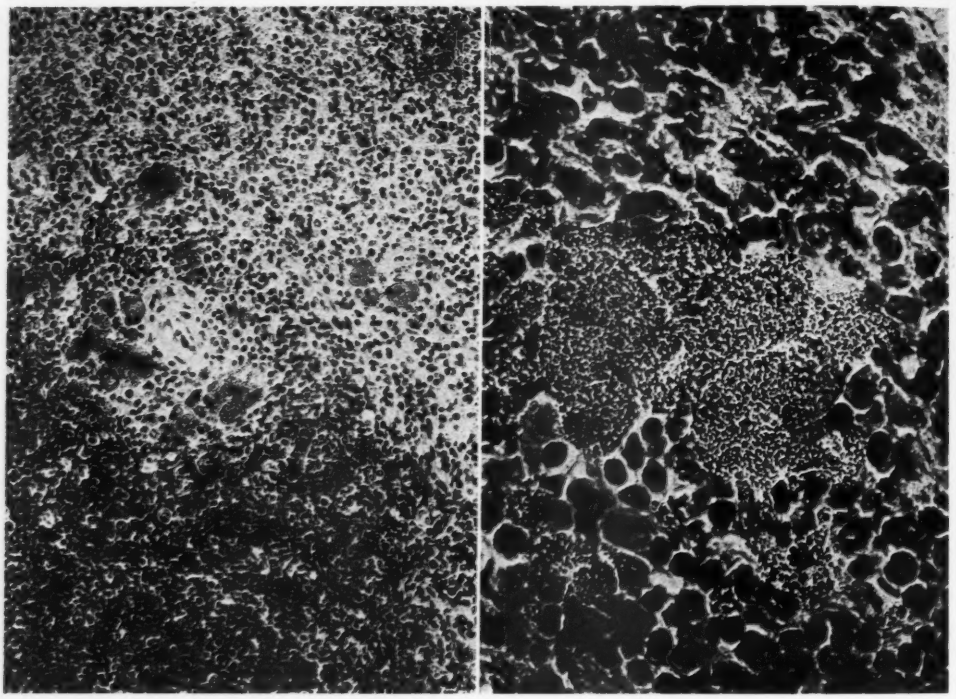

Fig. 2-*A*. Fig. 2-*B*.

Fig. 2-*A*. Section of the spleen showing cells laden with thorium in the pulp and in the peri-arteriolar tissue. Hematoxylin and eosin stain (× 240).

Fig. 2-*B*. Section of the spleen showing reticulo-endothelial cells in the pulp. They are laden with thorium and are markedly swollen. Hematoxylin and eosin stain (× 960).

At necropsy, the significant changes were found in the liver, spleen, lymph nodes, mediastinum, and femoral arteries. The liver weighed 1,150 grams, measured 21 × 14 × 6 cm., and was firm in consistency. It showed irregular surface depressions in a few areas. On section, the lobules were grayish and indistinctly delineated. There was a retracted, yellowish, streaked, fibrous network throughout. The spleen weighed 180 grams and measured 12 × 7 × 3 cm. The capsule was irregularly thickened. The organ was indurated and heavy, but not firm. The pulp was red and stippled with miliary yellowish deposits. A healed infarct was present in the upper pole. The lymph nodes showed no gross changes. There was a large cystic mass, six to seven centimeters in diameter, in the anterior superior mediastinum. It had a thick fibrous wall and was filled with brownish, jelly-like material. It was interpreted as an old hemorrhage. Thrombosis of both femoral arteries was present.

Hematoxylin and eosin preparations of the liver (Fig. 1) showed large masses of a thorium compound in the form of grayish-green granules. These were found largely in the portal spaces, where some of them seemed to lie free in the fibrous tissue, which was slightly increased. Other

masses of thorium compound were found in phagocytes in the portal spaces. Some of the sinusoids appeared to be occluded by large masses of the material. These lay in swollen Kupffer cells. Some of the portal canals containing this substance showed an associated infiltration with a few polymorphonuclear leukocytes. The polyhedral cells were not markedly diseased but did show a moderate amount of parenchymatous degeneration.

Sections of the spleen (Figs. 2-*A* and 2-*B*) showed large collections of the same type of granular material. These were massed in and about the splenic corpuscles (which were atrophic), near the fibrous trabeculæ, and near the sheathed arterioles. In these locations, the substance lay in large phagocytic reticulo-endothelial cells. In addition, thorium-laden reticulo-endothelial cells were scattered in the pulp. There was a moderate increase in the fibrous tissue. The infarct at the upper pole consisted of partially hyalinized collagenous scar tissue, among the fibers of which many masses of thorium granules were seen. These seemed to be extracellular. The large amount seen here was probably due to condensation with contraction of the scar.

A lymph node (Fig. 3) from the region of the gall-bladder bed contained large masses of thorium, both in germinal centers and in the reticulum throughout the lymphoid tissue. In hematoxylin and eosin preparations, the first impression was that of amyloidosis. There was marked fibrosis. The lymph nodes in the mediastinum contained no recognizable thorium, nor were they fibrotic. The bone marrow showed neither thorium deposits nor fibrosis. All of the cells containing the thorium compound showed a peculiar opacity of the cytoplasm. The cystic mass in the mediastinum appeared, on microscopic examination, to be an organizing hematoma.

MEASUREMENTS OF RADIO-ACTIVITY

Soon after the death of the patient on June 9, 1937, 131 grams of liver were ashed to 2.508 grams and measured on a Geiger counter. Insufficient precautions were taken to eliminate the beta rays and the standardizing source of radium was too strong. These data were therefore discarded. In December, the same ash was

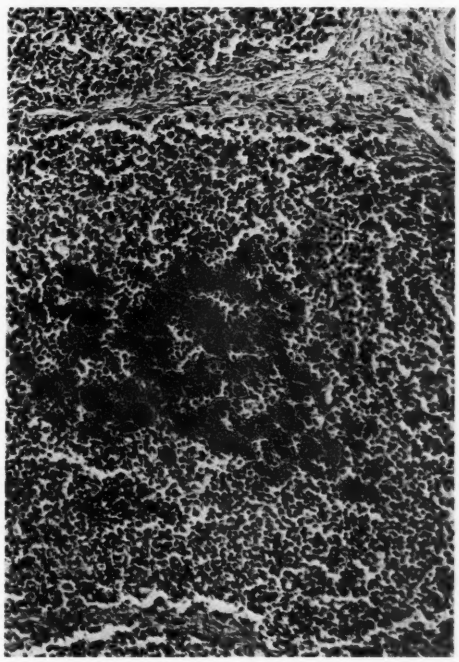

Fig. 3. Section of a perihepatic lymph node showing large numbers of reticulum cells, each enlarged and filled with thorium. Hematoxylin and eosin stain (× 240).

remeasured on another Geiger counter using a 2.5 mm. lead filter, but the counts were too few above the background. Three hundred and eighty-six grams of the liver, which had been kept for six months in 10 per cent neutral formalin, were ashed to a weight of 6.957 grams. This amount was sufficient to give good measurements.

A diagrammatic sketch of the set-up is given in Figure 4.

It has been reported (2) that formalin in which liver and spleen were preserved was not radio-active. A sealed bottle containing 90 c.c. of the formalin was placed about 6 centimeters from the center of the chamber and no increase in counts above the background was found. It was

assumed, therefore, that the radio-active material in the liver had remained undissolved.

A brief description of the method of measurement may be of value. The ash was contained in a glass bottle, the walls of which were about two millimeters thick. This bottle just fitted into a cylinder of lead 2.5 mm. thick, which was placed on centimeter graph paper, in order to aid in centering, at a distance of 10 centimeters from the center of the chamber. The bottle of ash could be removed and replaced by a 12 c.c. bottle of thorotrast or a gold seed containing radon. A brass cylinder, 0.8 mm. thick, surrounded the counter chamber to increase its sensitivity. This brass can also be considered as additional filter to the 2.5 mm. of lead and glass in removing the beta rays. The counts are due almost entirely to gamma rays.

A gold radon seed of 0.3 mm. gold filtration was used as the standardizing source. The seed was sealed into a glass vial in an attempt to prevent contamination of the counter. The radon seed was calibrated by the radium company when its strength was 0.3 millicurie. However, this was much too strong a source for the counter and it was used after it had decayed to 0.04 millicurie. Since the original method of measurement is not intended for accurate standardization work with such weak sources, the values based on this standard must not be judged to be of greater accuracy. The 12 c.c. vial of thorotrast was at least one year old.

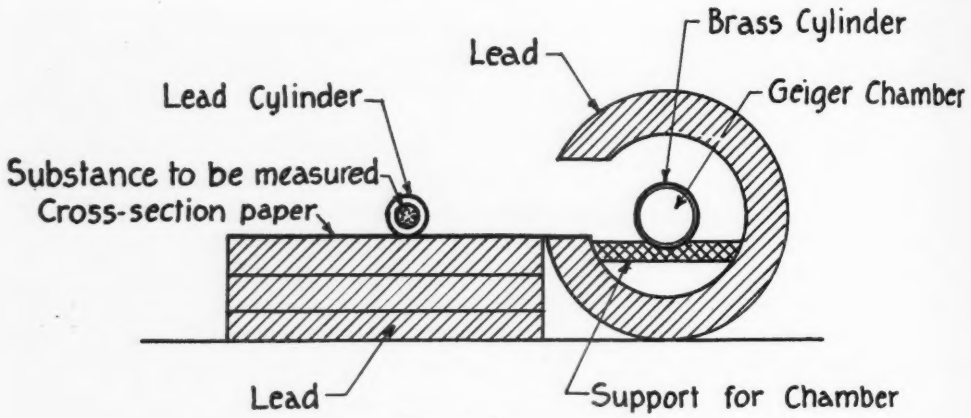

Fig. 4. Cross-section of apparatus.

Table I is a duplicate of the original data. It may be interesting to note in Table I that the lead cylinder increases the background from 17.4 to 18.6 and when it is put up closer, to 22 counts. Lead is generally slightly contaminated with radioactive material.

The results in Table II show that there still remained in the liver, five years after the injection of 75 c.c. of thorotrast, approximately 27 per cent of the original gamma-ray activity of the thorotrast. Using Taft's (2) results, which state that 75 c.c. of thorotrast are equivalent in gamma rays to 1.37 microgram of radium, this liver would still contain a gamma ray equivalent to 0.37 microgram of radium. According to the figures in Table I, this liver contains approximately 0.3 microgram. Although, as previously pointed out, the absolute value of the gamma-ray activity in the thorotrast has no greater accuracy than the measurement of the standard (1), it is of real significance to note that about 27 per cent of the thorotrast gamma-ray activity was present after five years.

In making exact measurements, one

should (*a*) make certain that the original radium or radon source is accurately standardized and is or has become sufficiently weak; (*b*) make certain that the equivalent filtration for the standardizing source, the

Taft (3) has found 51 per cent of the original dose in the ash of a liver a little over a month after the injection. According to the above measurements, there is 27 per cent five years after injection.

TABLE I.—MEASUREMENTS OF LIVER ASH, THOROTRAST, AND RADON ON GEIGER COUNTER

Conditions	Distance	Readings on Counter		Count	Time	Counts per min.	Background per min.	Corrected Count min. per
		From	To					
Brass cylinder on chamber		18:0	19:27	174	10 min.	17.4	17.4	
2.5 mm. thick lead cylinder at	10 cm.	3:0	12:19	1,118	60 min.	18.6	18.6	
12 c.c. thorotrast vial inside of Pb cylinder	10 cm.	14:0	17:2	364	10 min.	36.4	18.6	17.8
Liver ash in Pb cylinder	10 cm.	19:0	21:18	276	10 min.	27.6	18.6	9.0
Liver ash in Pb cylinder	10 cm.	0:0	7:15	870	30 min.	29.0	18.6	10.4
12 c.c. thorotrast vial inside Pb cylinder	10 cm.	8:0	11:1	362	10 min.	36.2	18.6	17.6
Pb cylinder close to chamber	x cm. close to counter	20:0	21:42	204	10 min.	20.4	20.4	
12 c.c. thorotrast in Pb cylinder	x cm. close to counter	12:0	18:1	722	10 min.	72.2	20.4	51.8
Liver ash in Pb cylinder	x cm. close to counter	22:0	26:0	480	10 min.	48.0	20.4	27.6
12 c.c. thorotrast in Pb cylinder	x cm. close to counter	26:0	2:2	724	10 min.	72.4	20.4	52.0
Pb cylinder	x cm. close to counter	8:0	9:50	220	10 min.	22.0	22.0	
Liver ash in Pb cylinder	x cm. close to counter	3:0	7:22	524	10 min.	52.4	22.0	30.4
Liver ash in Pb cylinder	x cm. close to counter	10:0	14:16	512	10 min.	51.2	22.0	29.2
Gold radon seed 0.0414 mc. in Pb cylinder	20 cm.	20:0	30 + 5:37	5,474	5 min.	1,095	18.6	1,076
Gold radon seed 0.0414 mc. in Pb cylinder	40 cm.	22:0	5:43	1646	5 min.	329	18.6	310

liquid thorotrast, and the ashed liver is the same. One suggestion offered by Dr. Steigmann, of Columbia University, is to inject 75 c.c. of thorotrast into a weight of liver equal to that under investigation, then ash this liver exactly as the latter, and compare equal weights of ash.

DISCUSSION

The explanation of the presence of fibrosis in the liver, spleen, and hepatic lymph node in this case is a complex question. It may very well be that these changes were present before the thorotrast was injected. However, if the pa-

tient were suffering from cirrhosis of the liver at that time (1932), it is unlikely that the process would not have advanced farther than the stage at which it was at the time of death in 1937. On the other hand, there is experimental work, as well as clinical observations, which would lead one to believe that the presence of thorium in an organ injures the parenchyma and stimulates the formation of fibrous tissue (5, 6, 7, 8, 9, 10, and 11). Naegeli and Lauche (12) found that thorium, after its primary deposition in the liver, spleen, and bone marrow, gradually moves to the regional lymph nodes of these organs; after three years the amount of thorium in the nodes may be large enough to cause necrosis. The amount of thorium seen in one of the hepatic lymph nodes in this case was greater than that seen in either the liver or the spleen.

In the light of these reports and the above findings, it seems likely that the changes noted at necropsy in this patient were due to the long-standing presence of thorium or its disintegration products and that the amount of radio-active substance present was sufficient to induce the fibrotic changes seen in the liver, spleen, and lymph nodes.

TABLE II.—CALCULATIONS FROM TABLE I

	Distance in cm.	Av. count per min.	Percentage	Equivalent γ-ray activity in mgm. radium
(1) 12 c.c. thorotrast	10	17.7		
(2) 386 gm. liver ashed	10	10.05		
(3) Percentage of counts of 12 c.c. thorotrast in ash	10		57	
(4) 12 c.c. thorotrast	Up close	51.9		
(5) 386 gm. liver ashed		29.1		
(6) Percentage of counts of 12 c.c. thorotrast in ash			56	
(7) Average percentage of counts of 12 c.c. thorotrast in ash			56.5	
(8) Percentage of γ-ray activity of 75 c.c. thorotrast found in 1,150 gm. liver			27	
(9) 0.04 mc. radon gold implant	10	4,304 calculated from		counts at 20 cm.
(10) 0.04 mc. radon gold implant	10	4,960 calculated from		counts at 40 cm.
(11) 0.04 mc. radon gold implant	10	1		9×10^{-3}
(12) 75 c.c. thorotrast calculated from counts in 12 c.c.	10	111		1
(13) 1,150 gm. liver calculated from No. 12				.27

SUMMARY

1. A case is reported in which 75 c.c. of thorotrast were injected intravenously five years before death.

2. The gross and histological findings in the liver, spleen, and lymph nodes are described.

3. The ash of a liver preserved in 10 per cent neutral formalin for six months showed that the liver still retained 27 per cent of the gamma-ray activity of the 75 c.c. of thorotrast injected five years previous to death.

4. Ninety c.c. of the formalin in a sealed bottle did not show any radio-activity.

5. The approximate gamma-ray activity of the liver ash was 0.3 microgram of radium.

6. It is considered likely that the pathologic changes noted were caused by the presence of thorium in these organs for a long period of time, and not to antecedent disease.

We wish to express our gratitude to Professor J. R. Dunning, of Columbia University, for the use of the Geiger counters, and to Dr. E. J. Baumann, of the Laboratory Division of the Montefiore Hospital, for ashing the liver.

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THE PRACTICAL AND EXPERIMENTAL ASPECTS OF THE ROENTGEN TREATMENT OF *BACILLUS WELCHII* (GAS GANGRENE) AND OTHER GAS-FORMING INFECTIONS[1]

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IN a period between August, 1928, and November, 1931, a little over three years, one of the present writers had the opportunity to treat eight cases of so-called gas gangrene infection with the x-ray, in conjunction with the other usual measures employed excepting amputation. In six cases the disease was confined to an extremity, and all of the patients recovered. Two cases involved the trunk, and both died. As reported (1) at the time it was thought that since all the extremity cases recovered, the trunk cases, being of much greater thickness, probably did not receive sufficient radiation to be considered as fair tests of the method, and it was recommended that in the future trunk cases be given more penetrating radiation.

Due to the rarity and seriousness of the disease, it was deemed justifiable to report the small number of cases observed up to that time, especially as the outcome in the extremity cases had been so strongly suggestive that the x-rays were of distinct benefit in this type of infection.

During the next four years some case reports (2, 3, 4, 5) appeared in the literature, and we continued to use the measure as the opportunity presented itself. In December, 1935, we presented it before (6) the Radiological Society of North America. Six months later we again presented the subject before the American Medical Association (7) in convention at Kansas City.

In preparation for this report we again sent out questionnaires and letters to everyone we thought might be able to add any case histories or other information to the problem. During the time covered by the first three reports, a period of about eight years, we treated and collected data on 56 cases, or an average of seven cases per year. The last questionnaire, covering a period of less than one year, brought in data on 87 additional cases. From the increase in the number of patients treated in this short time it is apparent that at least one of the purposes of our first report has been accomplished, that is, that others try the method. It is also gratifying to be able to report that the results in other hands have been as good or even better than in our own.

In all, about 100 physicians scattered throughout the United States and Canada, reporting from some of the best institutions on this continent, have combined to contribute to this study, data on 143 cases.

At this point, we wish to take a moment to thank sincerely not only those who contributed case histories, but also those whose courteous and encouraging replies to our questionnaire were of greater help than we have words to express.

By means of this general co-operation, it has been possible to establish in a short period of nine years, what we think are some important facts bearing on the treatment of a relatively rare but very fulminating and crippling, if not fatal, type of infection. Before presenting any figures we might state that we have been very much impressed by what we are to present and lest we become over-enthusiastic and state as facts matters which should really be stated only as opinions, we wish you to judge the evidence from your most critical point of view.

MORTALITY AND AMPUTATION

In support of our earlier statement that the co-operation of many clinicians has

[1] Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13–17, 1937.

been worth while in quickly establishing the value of the x-ray in treating gas gangrene, we shall submit some facts and figures regarding mortality and amputations. From the results obtained in the cases presented to-day as compared with our past experiences and the literature on the subject, we are positive that by using the x-ray we lower mortality and lessen the necessity for therapeutic amputations.

TABLE I

	Total Cases	Living	Dead	Percentage Dead	Extrem.	Trunk	Dead
Ordinary gas gangrene	123	113	10	8.1	105		6
						18	4
Diabetic and arteriosclerotic gangrene	9	4	5	55.5			
	132	117	15	11.3			

Has mortality been lessened by the use of the x-ray?

We are certain that the mortality rate alone is no longer the standard of successful treatment of gas gangrene, and would suggest that a strict score on amputations be kept and the number of amputations as well as the deaths be included in reports concerning methods of treatment in this group of infections in the future.

A brief analysis of the ten patients who died shows four trunk cases: two of these died in the first series (it was thought that they did not receive the proper type of x-ray) and in one instance, postmortem showed that only part of the involved tissues had been irradiated. The third trunk death received one treatment each day for three days, and the fourth trunk case that died was radiated only over part of the diseased tissues. In the first report, as a result of the first two trunk deaths, it was stated that all of the involved tissue should receive radiation with adequate voltage to penetrate the part, and that a treatment should be given morning and evening through every port. A satisfactory dose is 100 r per port per treatment.

In the extremity deaths, there were four cases that received but one treatment per day. As indicated above, this is not adequate. The other two extremity cases each received two treatments, one dying in 24 hours, the other dying in 18 hours after admission to the hospital. The clinician in each of these cases thought that death was due to injuries, but from the records submitted, we thought they showed evidences of severe toxemia and included them as gas gangrene deaths.

In the final analysis only the difficult cases die if they are x-rayed; that is, if treated with x-ray according to directions no case dies of gas gangrene that has not sufficient reason for death from causes other than the gas gangrene. When one considers the type of patient, either severely injured, senile, or debilitated, who develops gas gangrene, he will realize that in the primary disease, without the complication of gas gangrene, he has a variety of conditions, which in themselves will cause death in from 3 to 7 per cent of all cases.

The unfortunate individual who develops gas gangrene following a hypodermic injection may be an exception to those referred to as seriously injured, senile, etc. Unexplained pain, swelling, or fever following a hypodermic calls for an x-ray film for the presence of gas, and, if it is present, x-ray treatment is imperative.

AMPUTATIONS

In our first report we emphasized the facts that in no case was amputation necessary for any of the patients in that series; that no patient lost tissues because of therapeutic surgical procedures; that

any tissue removed was removed because of the severity of the injury. In our second and third presentations we were injury but for therapeutic purposes. The figures in Table II suggest that the deaths in the amputation group were not necessarily due to the severity of the injury since two of the three deaths were in the less severely injured group.

TABLE II.—COMPARATIVE DEATH RATE IN CASES OF ORDINARY GAS GANGRENE, WITH AND WITHOUT AMPUTATION

(Has the use of the x-ray made amputation unnecessary?)

Total No. Extrem. Cases	Amputations	Dead	No Amputations	Dead	Percentage Dead
105	33	3			9.1
			72	3	4.0
Necessary amp.	16	1			6.2
Therapeutic amp.	17	2			11.7

becoming quite strongly opposed to amputation as a therapeutic measure for gas gangrene. We are now absolutely opposed to it.

Table II shows a mortality of 4 per cent of cases in the non-amputation group as compared to 9.1 per cent mortality in the cases having amputation. This would seem to indicate that a patient can recover from gas gangrene without amputation; in fact, if there is no amputation and x-ray treatment is given, there is a better chance to recover than if there is an amputation. Some may say that it is unfair to figure the mortality in the amputation group against the non-amputation group, since many in the amputated group were so severely injured as to make amputation a necessity, hence they lost more blood, were in greater shock, and were, on the whole, poorer risks. Therefore, we checked the cases carefully and separated the cases in which amputation was done into two groups: (1) amputation of necessity, instances in which it was required by the character of the injury or done late in the disease after the acute phase of the gas gangrene had passed (removal of limb because of damaged tissue), and (2) a second group in which amputation was performed in the first few hours of the disease, not because of the severity of the

CONCERNING CORRECT DIAGNOSIS

The therapeutic amputation group is also very interesting because of its relation to the problem of correct diagnosis. A few doctors, mostly surgeons, have questioned the accuracy of the diagnosis of those cases that have been treated with the x-ray, but from the surgeon's point of view this group should be beyond question. Here are 17 cases with sufficient evidence of gas gangrene to warrant the surgeon's removal of an extremity, and surely no surgeon would remove an extremity for gas gangrene without satisfactory evidence that the patient had a gas-forming infection. But in this group of 17 cases, undoubtedly gas gangrene, only two died, or a mortality of 11.7 per cent, which some time ago would have been considered a very satisfactory record. It should be even more convincing when, as pointed out in previous reports, some of these patients still had gas in the tissues above the site of amputation but, regardless of that fact, recovered following x-ray treatment. There are x-ray films in the exhibit verifying this point. It would seem that these patients lost an extremity unnecessarily inasmuch as they still had the disease after the amputation. Their ultimate recovery can be attributed only to some cause other than amputation.

It is very pleasant to see the number of cases receiving x-ray treatment rapidly increasing, but to have many clinicians make a note on their records that "amputation was done because of the injury and not because of the gas gangrene" is most pleasant. Of these 33 amputations, 16 cases had such a notation, and, if we stop to consider, this means that only 17 out of 89 extremity cases were treated by the older method of immediate amputation on

diagnosis. It seems that this co-operation of many physicians in many States toward establishing the value of the x-ray in treating these cases has indeed been invaluable to these individuals who were permitted to keep their arms and legs.

No other series in the literature that we reviewed had such a small percentage of amputations. This 19.1 per cent should read "0 per cent" on all series in the near future.

Obviously no fixed law stating the time for the necessary amputations can be made.

One should not become over-enthusiastic regarding the use of the x-ray and neglect other measures. Surgery is commonly necessary in these cases and must be employed as indicated. Every case of gas gangrene is a serious clinical problem from the very start and no measure which might assist in the patient's recovery should be neglected.

DÉBRIDEMENT

There is no question but that a wound should be cleared of all foreign material and hopelessly isolated fragments of tissue as a result of severe injury. We do not intend to criticize the surgeon, but we are out to thoroughly discourage the surgeon who is inclined to unnecessarily mutilate or amputate. In the trunk cases there was no attempt at débridement and 14 out of 18 patients recovered, so one can recover without débridement.

In order to give the surgeon some support in a more conservative measure, such as the use of the x-ray, it will be necessary to establish the procedure in the literature, and, therefore, a plea is made for all to report their cases in detail through some source or other, preferably their state and special journals.

SERUM

The question of the use of serum is less important and more uncertain than any of the preceding aspects of the problem. To start with, we may state that there are 18 cases so far reported which have had no gas bacillus serum either prophylactically or therapeutically. There has been one death in these 18 cases, a mortality of 5.5 per cent, so it does not seem that the use of serum is essential to recovery.

TABLE III

Total No. Extrem. Cases	Necessary Amp.	Bal. Extrem. Cases	Therapeutic Amp.	Percentage Ther. Amp.
105	16	89	17	19.1

TABLE IV

	No. Cases	Serum	No Serum	Dead	Percentage Dead
Ordinary gas gangrene, trunk and	123	105		9	7.1
extremity			18	1	5.5

In Table IV the percentage dead is slightly lower among those who had no serum as compared to those who had serum, and there are sufficient numbers to be of some significance.

DIAGNOSIS AND CLASSIFICATION OF CASES

Gas gangrene as Graham (8) so clearly describes it, is a loosely applied term covering infections due to one or more of several anærobes. Other organisms are also found, so that the disease may not be by any means identical in detail in any two individuals.

In our reports up to this time, we have recognized only two types of cases, trunk and extremity, while now, as a result of our analysis of the additional data on hand, we are further dividing the disease into three different clinical phases: suspected cases, early cases, and late cases. In the suspected cases, the x-ray, when used, may be said to be used prophylactically. It would be used for that purpose in those patients who had an injury such as is commonly complicated by gas gangrene but before definite evidence of the disease is present. In the early and late

cases it would mean that the diagnosis had become definitely established, the early cases receiving x-ray treatment in the first 24 hours of the disease, while by the late cases are meant those in which the treatment is started after the first 24-hour period of active infection has elapsed.

TREATMENT—DOSAGE AND DANGERS

The Suspected Case—Prophylaxis.—In our animal experimentation work we thought we proved conclusively that the earlier treatment was started, the more easily the case was controlled and the sooner it subsided; and if treatment was started late it seemed to have much less effect.[2] Many of the patients who received one or two doses of x-ray and recovered were treated in the earlier stages; the disease seemed to regress immediately, the patient's own resistance apparently coming in to control the situation from that time. The ability of the individual to respond and apparently assist himself in the battle following a dose or two of irradiation is a rather impressive clinical fact and, once he gets control of the situation, he does not seem to lose it.

In view of the above facts, what is there to prevent the more extensive use of the x-ray as a prophylactic measure against the development of gas gangrene? Many surgeons throughout the country are taking advantage of its simplicity and using it on all compound fractures. We sincerely

Fig. 1. Gas gangrene following hypodermic injection. H. G., male, aged 27, was given a hypodermic injection of boiled milk for a chronic Neisserian infection 24 hours before admission to the hospital. Within eight hours patient developed a large amount of swelling, with escape of gas at the site of injection. Patient was hospitalized, multiple puncture wounds were made throughout the thigh, and deep irrigations with potassium permanganate solution. He received a single treatment with mobile x-ray unit at 1:30 P.M. and was dead at 3:45 P.M. the same day.

This case is instructive from several angles. Any hypodermic injection followed by unusual symptoms, especially an unusual amount of pain, should have an x-ray film searching for gas in the deep tissues. If gas is present, x-ray treatment is imperative. This patient lived only two hours after the first x-ray treatment and less than 24 hours after receiving the hypodermic. Obviously, treatment was started too late for this type of infection, which is deep-seated and almost entirely sealed up, resulting in the rapid growth of organisms and complete absorption of toxin. The mobile unit used was probably inadequate. Heavier voltage through the thigh and trunk, including heart and large viscera, might have been more effective. Pasternack and Bengtson (9) show the damaging effects of the toxin on the viscera, and the quantity of toxin absorbed may be of more importance than the number of hours the infection has existed before treatment is started. This man was probably beyond help at the time of admission.

Since completing this article, four cases of gas gangrene following hypodermic injections have been reported to us, with but one recovery. This would indicate that this type of case must be treated early and thoroughly if any good is to be done. The earliest method of diagnosing the presence of a gas-forming infection following hypodermic injections is undoubtedly by the use of an x-ray film. If gas is present, x-ray treatment should be given. If the gas is of accidental origin, no harm will be done; if due to infection, much good may be accomplished.

[2] The work of Pasternack and Bengtson (9) may explain the reason for this. They point out that vital organs, heart, kidneys, etc., are severely damaged early in the toxemia of *Vibrion* septic infection.

endorse this procedure, and in answer to any criticism as to its use for this purpose we have only to ask this question of the critic, "If you had a compound fracture, would you prefer the risk of gas gangrene to a few simple x-ray treatments which would in no way disturb or annoy you?" The answer is obvious.

A definite amount of x-ray to cover all cases will never be stated, as each case is a distinct clinical problem, but the x-ray is so effective that anyone with a working knowledge of radiation therapy should have no trouble in successfully treating a case if he is not compelled to start too late.

The thicker the part the higher the voltage and the more filtration is indicated, but since it is only necessary to treat over a period of three days, or at the longest five days, making the number of treatments vary from six to ten, no complications should arise from the use of 100 r per port per treatment, regardless of how many ports it may take, if the correct voltage and filtration are used. If treatment extends beyond the third day, unless new areas are being treated, 50 r per port might be sufficient. An increase in filter would also add to the protection of the patient.

FILTER

It should be understood, but apparently it is not, that no treatment was ever recommended with less than 0.5 mm. aluminum filter. Since 0.5 mm. aluminum filter is so small that many radiologists appear to consider it no filter at all, and have repeatedly treated cases without filtration, we wish again to make a plea for the use of filtration—at least 1 mm. of aluminum in all cases.

Many cases have recovered with the use of filtration up to 0.5 mm. of copper, and since recovery is possible with the use of filtration, and the absence of filtration may lead to serious complications, it seems only fair to these patients that some filter be used. The absence of filter during treatment can, we believe, be a legitimate source of criticism of the use of the x-ray in the treatment of gas gangrene. Only one case so far has reported skin reaction from treatment, but we feel, from the dosage indicated on the record in one patient who died very early, that radiation necrosis would have been a possibility had the patient lived.

The question of the x-ray as a factor in preventing proper repair of the damaged tissue has been raised. So far, no com-

Fig. 2. Extension of gas gangrene following amputation. G. E. L., white male, aged 12, received injury to left forearm. Prophylactic and therapeutic serum administered. Amputation was done after diagnosis of gas infection was made. Amputation was below elbow. Gas infection extended up the arm into shoulder and adjacent thorax. X-ray therapy controlled this infection and the child made a quick recovery.

This was one of the early cases and it served to impress us with the fact that the amputation was unnecessary in that it had no therapeutic value. In this case a boy, aged 12, must go through the rest of his life without a wrist or hand. Again we wish to state that amputation of an extremity as a therapeutic measure for the treatment of gas-forming infections is an obsolete procedure. If amputation is necessary because of the severity of the injury, that is another matter, but as a therapeutic procedure for gas infection, it is poor practice.

plications have arisen in any of the cases to indicate that the amount of x-ray used is in any way detrimental to the normal

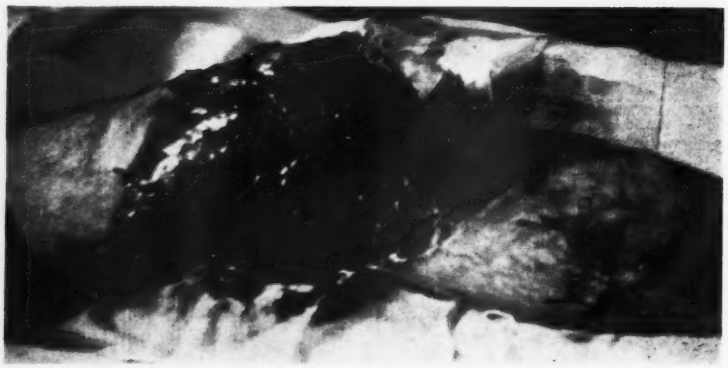

Fig. 3. Shows extent of injury. (See caption under Figure 5.)

and natural process of healing in any of the wounds treated. However, let us emphasize again that we have no reason to suspect that these tissues are immune from radiation necrosis following overdosage with x-ray, and we believe that in justice to the patient the ordinary precautions against radiation burns should be taken. Therefore, please use some filter and your best judgment. The use of filter tends to protect the patient against accidental over-radiation and, as far as we know, does not prevent the patient from receiving full benefit of the radiation given. This opinion has also the support of findings on experimental animals.

SPACE FACTOR

The reason for treating twice each day has been asked many times. The reason is only an opinion based on a clinical observation that the results were better when the space factor, or length of time between treatments, of the various infectious diseases, approximately coincided with the rate of growth on culture media or by clinical estimation of the etiologic organisms. For example, it has been our custom to treat blastomycosis, glandular tuberculosis, and many other slowly growing organisms with a relatively long space factor, that is, four or five days between treatments. More rapidly growing organisms such as the *Staphylococcus*, found in the ordinary boil or carbuncle, we treat with a somewhat shorter space factor, once each day; but in erysipelas, which is more fulminating in character, we have used a still shorter space factor which we thought more nearly approximated the growth cycle of the organism, and treated twice each day.

Since gas gangrene is undoubtedly as fulminating in character as erysipelas, it seemed to us that if any good was to come from the x-ray treatments, it should be from a series of treatments with a short space factor. The purpose in treating twice each day was to interrupt or in some way disturb the normal growth cycle of the organism if possible. Maybe this was accomplished, preventing the organism from producing its toxin, or it may be that the x-rays affect the toxin directly after it is produced, and by frequent x-ray treatments, prevent any great accumulation of the toxin in the tissues in a given time. Whether or not the x-ray has any antitoxin action, or in what way it aids the tissue in absorbing, neutralizing, or otherwise detoxifying the infected tissues seems to us to be a very fundamental problem.

It might be well to make a plea that more

radiologists become interested in the x-ray treatment of infectious processes and by carefully kept records build up data, not only on the organisms which are locally destructive, such as the *Staphylococcus*, but also in that group of bacteria which are toxin-producers and amongst which are some of our most serious infectious diseases.

EARLY CASES

An early case has been defined as one in which the x-ray treatment is started before 24 hours have elapsed after the disease has become active. Of these cases, 100 per cent should recover.

Fig. 4. Shows gas in the tissues. (See caption under Figure 5.)

LATE CASES

Late cases are those patients who receive no x-ray treatment during the first

Fig. 5. M. S., white male, aged 23, received severely lacerated wound to knee area on April 12, 1937. Admitted to hospital immediately and received prophylactic gas and tetanus serum. The following day gas infection was evident. Received two x-ray treatments per day for three days. Patient responded promptly to radiation therapy and, in spite of the severe laceration, no amputation was done—skin graft was finally necessary.

The x-ray reproduction shows gas in the tissues (Fig. 4). Clinical photograph shows the extent of the injury (Fig. 3). Organisms cultured from this wound were used to infect the guinea pig, the film of which shows gas in the soft tissues of the left thigh and left sacral region (Fig. 5). The pig died from gas infection in spite of x-ray therapy. The animal experimental work with gas organisms has never given as satisfactory results as have been obtained clinically. The guinea pig may be hypersensitive to the infection. At any rate those who refuse to treat their patients because the animal experimental work is not successful are making a serious mistake. In this instance the same organism that killed the guinea pig responded very well in the human.

24 hours of their disease. Never refuse to treat any patient because he is apparently a hopeless case, but in these seriously toxic cases in which treatment is started late, such as the case reported by our late colleague, Dr. Willis Manges, it requires courageous measures and persistence on the part of the radiologist. From the record on this case, it is apparent that in less capable hands this patient would have undoubtedly died, but Dr. Manges' final switch to heavier voltage and greater filtration and the inclusion of more areas was promptly rewarded by a distinct improvement in his patient's condition. In the late cases it might be well to treat three times the first day or treat every five hours for three doses, if it can be arranged.

Fig. 6. A. H. B., white male, aged 23, fell from the third story in construction work, sustaining a compound fracture of the middle third of the left femur. The following day gas infection was apparent and x-ray treatments were given over the proximal end of the femur and the left side of the abdomen to prevent extension of the infection. The leg was not treated.

Since it is the toxemia which kills, we feel that all the involved area should be treated, as toxin is being formed in all of the infected tissues. Therefore, it is not sufficient to treat only the upper border or just a part of the infected tissue. In our first report, in 1931, we stated that all suspected tissue should be treated with x-ray with sufficient kilovoltage to penetrate the area involved and that these treatments should be given twice each day.

This patient had sufficient reason to die from his injury, but was placed among the gas gangrene deaths as we felt from the clinical record submitted that he undoubtedly died from the gas gangrene. Treat above and below the site of injury; treat wherever you think toxins are being formed.

From the recent work of Pasternack and Bengtson (9) who show the toxin of *Vibrion* septic has powerful cardiotoxic properties, if not a special affinity for the heart, it might be well to treat directly over the heart as well as the other involved tissues in cases in which treatment must be started late in the course of the disease. These workers also show lesions in many other organs and, as they are continuing their study in the anærobic infections, undoubtedly they will give us some definite guides in the treatment of this mixed group of infections.

THE STATUS OF THE X-RAY IN TREATING INFLAMMATORY DISEASES

It was called to the writers' attention by the late Dr. Willis Manges that the apparent specific action of the x-ray in treating gas gangrene was the first indisputable evidence the radiologist had to support his contention that the x-ray was of value in the treatment of the inflammatory lesions.

For many years many radiologists of mature clinical judgment had the value of the x-ray clearly demonstrated in treating a great variety of infections, but the clinician refused to be convinced and would generally claim that the patient recovered because of other measures employed in the treatment or that the lesion was self-limited and that the patient would have recovered without any treatment. The radiologist was generally obliged to admit that there was some truth in these statements. However, in gas gangrene we are dealing with an infection which up to this

time has resisted all forms of direct therapy. The only treatment known to be consistently effective was the complete removal of all the infected tissues, and the patient invariably died very soon unless the removal of the infected area was accomplished. Dr. Manges claimed that in gas gangrene we had an infection which was neither self-limited nor influenced by any other measure, and up to this time very rarely recovered without removal of the diseased part. The prompt and consistent action of the x-ray in gas gangrene, in his opinion, established beyond doubt the status of the x-ray in the treatment of inflammatory diseases.

Fig. 7.

Fig. 8.

J. D., white male, aged 58, admitted to hospital suffering from an untreated diabetes of five years' duration and gangrene of both feet (Fig. 7). Patient cut a corn on his right foot April 27, 1937. This started a gangrenous process. X-ray film (Fig. 8) of right foot on May 14, 1937, showed gas in the tissues near heads of fourth and fifth metatarsals.

On May 27, 1937, after several days of pre-operative preparation including some x-ray treatments to both legs, the left leg, which was the lesser involved of the two, was amputated just below the knee. The stump of the left leg was treated following amputation but the next day the patient appeared toxic and showed a rise in temperature which suggested reactivation of the gas infection. The gangrenous area on the right foot was then included in the x-ray treatments and the toxic feature immediately cleared up. It is possible that the x-ray treatments controlled the toxin formation in the stump of the left leg, but the shock of the operation permitted the gas organisms to become active in the right foot and this, in turn, was controlled by x-ray when this area was treated; at any rate, he improved. The left stump progressed normally and the right leg was amputated on June 2, 1937. Both stumps were then treated until June 7, 1937, when x-ray was discontinued as there was no evidence of gas infection in either stump and the patient appeared to be in good condition.

The patient died one week later and postmortem showed evidence of active gas infection which had not been observed by the clinician and had not been reported to the x-ray department.

This case indicates the necessity of treatment over a long period of time because a reactivation of the infection may occur. If reactivation should occur, immediate x-ray treatment is imperative. This type of patient requires close co-operation between internist, surgeon, and radiologist, and even then may die of his disease. This type belongs in a separate group entirely from the gas-forming infections following injuries and its management is much more complicated. During the course of such a case as this, one is impressed with the value of the x-ray in controlling the apparent toxic condition of the patient while the organisms remain and again become active toxin-producers with each new shock.

SUMMARY

Since August, 1928, we have treated cases ourselves and collected data from various radiologists and surgeons throughout the country on 143 cases of gas gangrene infection treated with x-ray. The data bearing on the treatment were analyzed, and the conclusions formerly drawn are substantiated. No case which has been treated according to the suggestions con-

tained in the report in 1931 has died of gas gangrene.

The lowered mortality and the number of recoveries in the non-amputation group and in the no-serum group proved beyond question that the use of the x-ray in treating gas gangrene approaches the action of a specific in that it is by far the most effective measure so far employed. There are no contra-indications to its use by a qualified radiologist.

Severe débridement measures are no longer justifiable.

We cannot over-emphasize our opposition to amputation because of gas gangrene and feel that anyone amputating or advocating the amputation of an extremity solely because it is infected with a gas-forming organism is definitely out of touch with the proper and conservative treatment for the condition.

In addition to lowering mortality, we are certain that many arms and legs have been salvaged for the patients who recovered. A low mortality rate is no longer the sole standard of successful treatment of gas gangrene, if it has been obtained at the sacrifice of many extremities. We suggest that in the future a strict score on amputations be recorded and the number of amputations as well as the deaths be included in reports concerning methods of treatment in this group of infections.

Concerning the question of diagnosis in the cases treated with x-ray we might, for the benefit of the ever skeptical surgeon, mention the fact that there were 17 cases with sufficient evidence of gas gangrene to warrant the surgeon's removal of an extremity for gas gangrene, and surely no surgeon would amputate without satisfactory evidence that the patient had a gas-forming infection. But in this group of 17 cases of undoubted gas gangrene, only two died, a mortality of 11.7 per cent, which some time ago would have been considered a very satisfactory record. It should be even more convincing when, as pointed out in previous reports, some of these patients still had gas in the tissues above the site of amputation.

Some patients recovered following two or three x-ray treatments, but they were treated early in the disease. Animal experimentation also proved that early treatment was extremely effective. With these factors in mind the division of the cases according to the clinical phase in which treatment was started seems indicated, and they were, therefore, divided into suspected cases, early cases, and late cases. If treatment is started while the case is still under suspicion or before a definite diagnosis has been made, it should not develop gas gangrene. If treated early, that is, during the first 24 hours of the disease, there should be a 100 per cent recovery. By use of the x-ray film one may make a diagnosis very early, with the first accumulation of gas in the deep tissues, and this method of examination is essential if gas gangrene is suspected. We advise prophylactic use of the x-ray in suspected cases; in fact, in all types of injuries such as commonly develop gas gangrene infections.

Patients complaining of an unusual amount of pain following a hypodermic might well be x-rayed for gas in the deeper tissues, as this infection following hypodermic injection has been reported in the literature.

If treatment is started after the first period of 24 hours has elapsed, recovery will not be so certain and it is likely that 10 or 15 per cent of these patients will die. Since it is the toxin which kills and toxin is being formed in all of the infected tissue, it is absolutely essential that all the involved tissue be treated. The use of the x-ray in treating gas gangrene has definitely settled the contention of the radiologist that the x-ray is of value in treating inflammatory lesions, since no other treatment has ever been effective when directly applied to the involved tissue in gas gangrene. The usual method was removal of the infected part if the patient was to recover—if x-ray treatments are given this is no longer necessary.

In order to give the surgeon some support in a more conservative measure, such

as the use of the x-ray, it will be necessary to establish the procedure in the literature, and, therefore, a plea is made for all to report their cases in detail through some source or other, preferably their state and special journals.

The x-ray has also been of benefit in treating the arteriosclerotic, diabetic cases developed the complication of gas gangrene.

The use of serum is not absolutely essential to recovery, and its use should be conservative, avoiding serum sickness, which only adds to the patient's difficulty. Tetanus serum must be given.

Some filter and adequate kilovoltage to penetrate the involved part must be used.

Up to this time no patient has died of gas gangrene who has received a treatment in the morning and a treatment in the evening for three days over all of the involved tissue.

The analysis of the data so far available in connection with the x-ray treatment of gas gangrene seems to prove that x-ray treatment, properly given, is the answer to the question of what to do in treating a gas-forming infection. The space factor and the variable growth cycle of the organisms in the inflammatory lesions are briefly discussed in relation to the original method of two x-ray treatments each day.

These conclusions would not have been possible had it not been for the generous co-operation of many clinicians in various parts of the country who were kind enough to contribute data on their cases. The procedure of soliciting other clinicians' material is not looked upon with special favor by the writers, but in view of the arms and legs and probably the lives at stake in this problem it seems to have been justifiable. The writers wish to acknowledge the generous co-operation of all those who contributed in any way to this presentation and they number well over a hundred physicians in 25 States of the Union and one Province in Canada.

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CASE REPORTS

BILATERAL SYMMETRICAL EXOPHTHALMOS DUE TO RETROBULBAR LYMPHOSARCOMA

REPORT OF A CASE

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The occurrence of acquired bilateral symmetrical exophthalmos is usually due to hyperthyroidism and only rarely to retrobulbar lesions. Unilateral exophthalmos due to a variety of retrobulbar lesions is not rare, but so far as we could determine, no reference has been made to the clinical picture described below.

CASE REPORT

Mrs. M. M., white, aged 55, entered the St. Vincent Charity Hospital on April 18, 1934, complaining of swelling of the neck and bulging of the eyes. The patient had noted a small, firm swelling in her neck one year previous to admission. This swelling was painless, non-tender, and gradually became more firm and larger. About six months later the patient noted increased prominence of the eyes associated with impairment of vision, nervousness, and occasional night sweats. At this time the swelling in the neck increased rapidly. There had been no tremor of the hands, and the appetite had been only fair. Three months prior to admission the eyes became "sore" and reddened. There had been a weight loss of 45 pounds in the previous year.

Physical examination revealed a moderately obese white female, aged 55, with marked bilateral, symmetrical exophthalmos, edematous, and diffusely injected conjunctivæ, and puffy and sagging lower lids. The temporal fossæ were filled with diffuse, smooth, firm, non-tender masses, and nodular tumors composed of enlarged, firm, fixed, and matted lymph nodes were present in the neck. The axillary and inguinal nodes were similarly involved. There was dullness to percussion over an area extending 2 cm. beyond each side of the sternum in the aortic region and a firm, non-tender, rounded mass about 4 cm. in diameter was palpable in the epigastrium. Firm nodular masses could be felt on each side of the pelvis through the rectal wall, and there was a red and brawny swelling of the right foot and ankle. A slight secondary anemia was present, and only 3,000 white blood cells per cu. mm. of blood, of which 79 per cent were polymorphonuclear leukocytes. No abnormal blood cells were found. A biopsy of one of the cervical nodes revealed lymphosarcoma.

On the suspicion that the cause of the exophthalmos was retrobulbar tumor, the left retrobulbar region was given approximately one-half of an erythema dose of x-ray, and within 12 days the exophthalmos in that eye had considerably diminished, while the exophthalmos of the right eye persisted. X-ray therapy to the other eye resulted similarly in prompt diminution of the exophthalmos and in improvement in vision. The mediastinum, the cervical, axillary, and inguinal regions were then treated, and by July 8, 1934, the day of discharge, the masses had nearly disappeared.

The patient was followed in the out-patient department and was re-admitted to the hospital on July 20, 1934, because of swelling of the legs. There was no exophthalmos, but the cervical, axillary, and inguinal nodes were again enlarged, the largest node in the left axilla measuring 3 cm. in diameter. The white blood cell count on this admission was 5,100, with a normal differential picture. X-ray therapy was continued but gave only slight beneficial results. The patient began to lose weight and by the end of the forty-fifth hospital day firm nodules measuring from 0.5 cm. to 1 cm. in diameter were palpable beneath the skin in almost every region of the body. The patient insisted on leaving the hospital and was re-admitted on Oct. 28, 1934, with marked dyspnea, ascites, and edema of the lower extremities. There were signs of fluid in both pleural cavities, more on the left. There was moderate exophthalmos, and the lymph nodes everywhere were enlarged. The white blood cell count at this time was 2,350. About 2.2 l. of turbid, yellow fluid were aspirated from the pleural cavities and 4.8 l. of similar fluid, from the abdomen. Cultures of these fluids yielded no growth. The patient declined rapidly and died on the fifteenth day of the third admission.

At autopsy, all lymph nodes were found greatly enlarged, discrete, of a flattened, rounded shape, pink in color, and soft in consistency. They varied from $1 \times 2 \times 2$ cm. to $1 \times 5 \times 7$ cm. in size and were occasionally densely adherent to surrounding structures. The histologic picture of these nodes was that of lymphosarcoma. Similar neoplastic involvement was found in the peri-orbital fat which contained nodules 0.5 to 1.0 cm. in diameter. Lymphosarcomatous infiltration was also present in the following situations: diffusely throughout the peritoneum, the

perirenal tissues on the left side, the periureteral tissues, the mesentery, the temporal muscles, and the choroid plexuses. It is of interest that no tumor was found in the spleen.

Turbid yellow fluid was present in both pleural cavities, and bronchopneumonia was found in the lower lobe of the right lung. There was also a generalized fibrino-purulent peritonitis caused by the pneumococcus.

CONCLUSION

A case of generalized lymphosarcomatosis with bilateral symmetrical exophthalmos due to retrobulbar lymphosarcoma is reported. The exophthalmos disappeared completely after x-ray therapy, but reappeared shortly before death. At autopsy, lymphosarcomatous tissue was demonstrated in the retrobulbar fat.

FRACTURE OF THE TIBIA IN SPINA BIFIDA VERA

REPORT OF TWO CASES

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Neuropathic lesions in the lower extremities developing in patients with spina bifida vera are well recognized. Perforating ulcers of the feet and neuropathic joints have been described. The changes observed following fractures of the tibia in two of our patients with spina bifida vera, club foot deformities, and sensory disturbances of the lower extremities are of sufficient radiographic interest to warrant reporting.

Case 1. J. W., a girl five years old, was readmitted to the hospital on July 12, 1937, with a provisional diagnosis of sarcoma of the left leg. This child had previously been treated in the Department of Orthopedics for bilateral club feet associated with spina bifida vera. She was last seen by them in January, 1937, and was sent home wearing short leg braces.

Present Illness.—On June 20, 1937, the child began to complain of aching pain along the medial aspect of the upper third of the right leg. Five or six days later the mother noticed swelling on the lateral surface just below the knee. When off her feet the swelling would subside and pain was relieved. A week before admission it was noted that swelling was constant. There was no history of a specific trauma although the child was awkward and fell frequently.

Physical Examination.—The child was a well developed, and well nourished girl of five. Examination of the back showed a large spina bifida vera at the level of the twelfth dorsal, first and second lumbar vertebræ. The accompanying soft tissue tumor measured 14 × 12 cm. in size. The right leg showed a large

Fig. 1. Anteroposterior and lateral views of the right leg of Case 1 showing nearly obliterated fracture line in upper tibia, extensive periosteal reaction, and excessive callus which has displaced the fibula.

mass 9.5 × 9.5 cm., located along the lateral anterior and medial aspects of the upper third. This was attached to the deep structures but not to the skin. There was no tenderness to palpation. The overlying skin was tense, hyperemic, and definitely warmer than the corresponding area on the left leg. However, the mother stated that the right leg had always been warmer than the left.

Neurologic Findings.—There was complete anesthesia of the lateral, and reduced sensibility of the medial aspect of both legs. The knee jerks, tendo-Achilles, and plantar reflexes were absent. It was felt by the examining neurologist that the sensory reduction and absence in the lower extremities would allow a fracture in the upper right tibia to cause very little discomfort.

Radiographic Examination.—Anteroposterior and lateral films of the right leg showed definite

enlargement of the upper leg below the knee (Fig. 1). There was a transverse, somewhat irregular fracture line 3 cm. below the upper end of the tibia. The fragments were in full apposition. Posterior and medial to the fracture there was a mass of new bone 2.5 cm. in its superior-inferior, 1.5 cm. in its anteroposterior, and 1 cm. in its lateral diameter. This newly deposited bone showed no evidence of striation or trabeculation. In the anteroposterior view the upper end of the fibula was displaced laterally 1 cm. There was marked periosteal reaction along the tibia for a distance of nearly 10 cm. There was no evidence of destruction of the old cortex and no break in continuity except at the fracture site. It was the opinion of the radiologist that this was a simple fracture with excessive callus formation but that there was sufficient doubt in the diagnosis to warrant a biopsy. The biopsy was done on July 15, 1937, and a small amount of osseous tissue was removed. This had the gross appearance of ordinary callus.

Fig. 2. Anteroposterior and lateral views of left leg of Case 2 showing thickened cortex, fragmentation, and sclerosis of metaphysis with widening of epiphyseal line.

Pathologic Report.—"Both cartilage cells and osteoblasts are normal-appearing. The histologic findings are explained on the basis of reactive bone formation. Diagnosis: Cartilage and osteoid tissue."

Case 2. M. N., a girl of five and one-half years, had also been treated by the Department of Orthopedics for a right club foot. The history states that the child was born with a spina bifida vera which had been operated upon when she was two days old. When last seen by them on Aug. 10, 1936, the club foot deformity was well corrected and the child was in good health. She was again brought to the hospital on Dec. 3, 1937, for consultation and radiographic examination. History and physical findings are not available to us as treatment was carried out elsewhere. We have learned that the Kahn and Wassermann tests were negative and that there was impaired sensation of the lower extremities. Reports of roentgenographic films previously taken elsewhere and not seen by us are as follows:

"April, 1937. Anteroposterior and lateral views show a fracture situated 1.5 in. distal to the epiphyseal line of the left tibia. No displacement."

"June, 1937. Anteroposterior view shows in the left tibia a fracture located 1.5 in. below the epiphyseal line. There is considerable callus formation present."

"August, 1937. Anteroposterior and lateral views show the fracture as described previously but it appears there is some involvement of the inner side of the epiphyseal line. There is abundance of callus. In this view there is also a fracture of the lower tibia just one inch proximal to the epiphyseal line. Good alignment with callus formation."

Radiographic Examination.—Anteroposterior and lateral films of the left leg made by us on Dec. 3, 1937 (Fig. 2), showed no fracture line to be present either at the upper or lower end of the shaft of the tibia. The cortex along the entire shaft of the tibia was dense and greatly thickened. It varied in thickness from 5 mm. in the midportion of the shaft to 10 mm. in the lower end posteriorly. The epiphyseal line of the upper end of the tibia was widened. The metaphysis was fragmented and displaced slightly laterally except for one fragment 10 × 13 mm. in size which appeared to remain attached to the epiphysis. The upper end of the fibula was also displaced laterally 5 mm. The diagnosis of bone syphilis was entertained until knowledge of available clinical data was obtained.

COMMENT

The principal interest in these cases lies in the fact that they demonstrate a complicating factor in the diagnosis of fracture of the tibia when there is sensory impairment in the lower extremities associated with spina bifida vera.

In Case 1 the clinical picture was more sug-

gestive of sarcoma than fracture. A deep-seated tumor attached to bone was present. The overlying skin was movable and reddened. Pain was aching in character and aggravated by use of the extremity. There was no history of adequate trauma, no crepitus or false point of motion, and no point tenderness such as would be expected with fracture. After roentgenographic examination there was still sufficient doubt in the diagnosis to warrant a biopsy.

In the roentgenograph made by us in Case 2 the cortical thickening of the shaft, the irregularity and sclerosis of the metaphysis have more the appearance of bone syphilis than old fractures. We believe that without knowledge of the previous roentgenographs showing fractures, a negative Wassermann, and sensory impairment of the lower extremities, that the correct diagnosis could not have been made from our films. It should be noted that the club foot deformity in this patient was on the right, and the fractures were on the left.

In our opinion the etiology of the complicating factor in our two cases is similar to that seen in joint lesions in tabes and syringomyelia. Decreased sensibility allowed use of the extremities even in the presence of fracture, thus producing sclerosis, fragmentation, and excessive callus formation which complicated the diagnosis.

We wish to express our appreciation to Arthur Steindler, M.D., for permission to report these cases.

SURGICAL EMPHYSEMA, PNEUMOTHORAX AND PNEUMOPERITONEUM

A ROENTGENOGRAPHIC STUDY OF A CASE

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Surgical emphysema, pneumothorax, and pneumoperitoneum occurred, in this case, in the course of a closed ether anesthesia administered for the removal of a foreign body within the esophagus. Roentgenographic studies revealed not only the extent of the distribution of the ether vapor within the body, but gave some hint as to the anatomic pathways followed by the gas in its permeation through the various tissues.

CASE REPORT

G. S., a boy four years of age, was admitted to the Mount Sinai Hospital on July 1, 1937, with a history of having swallowed a five-cent piece 36 hours previously. He complained of considerable pharyngeal discomfort and a fluoroscopic examination made in a private laboratory, two hours before admission to the hospital, revealed the coin to be within the esophagus about two inches below the hypopharynx. It was felt advisable to remove it immediately by esophagoscopy. Ether anesthesia was administered through nasal catheters, the tipsof which extended into the nasopharynx. There was some difficulty in maintaining the patient properly under the anesthetic and it appears probable that for a short time the ether vapor was fed at an excessive pressure. After about five minutes, it was noticed that the patient was developing a surgical emphysema of the face, neck, and shoulders, and the anesthetic was discontinued. That night and on the following day the patient showed slight dyspnea, considerable restlessness, and was bothered by excessive mucus in the throat. The temperature was 101°, pulse 120, and respirations 28. Clinically there was a well-marked surgical emphysema involving the face, neck, shoulders, chest, abdomen, and back down to the mid-thigh. X-ray studies were made on the following three days. With absorption of the gas, the boy's symptoms gradually cleared up and he was discharged on July 6. The coin, which as a result of the relaxation associated with the anesthesia, appears to have slipped down into the stomach, was passed by rectum on the eighth day.

ROENTGEN FINDINGS

Over the abdomen, chest, and back the distribution of the gas was, for the most part, subcutaneous—slightly more marked on the left side. There was some collection of gas between the chest wall and scapulæ. Various muscle bundles in the neck were clearly visualized because of infiltration of the gas in the interfascial spaces.

The chest showed a definite mediastinal emphysema slightly more marked on the left side. The trachea was in the mid-line. The left lobe of the thymus was clearly outlined by gas distributed around it. The anterior border of the left lung was clearly visualized. The left border of the descending aorta was sharply demarcated by gas which tended to form a bulb-like collection just above the diaphragm. There was a small amount of gas in the left pleural cavity visualizing the outer border of the left lung up to the second rib.

The abdomen showed an unusually clear visualization of both kidneys due to distention of the perirenal fasciæ by gas. The psoas muscles stood out in bold relief. The peritoneum appeared dissected off the abdominal wall, especially in the left lower quadrant. A small amount of gas could be seen within the peritoneal cavity outlining the right border of the liver and under the left dome of the diaphragm outlining the spleen. A small amount of gas

was present over the buttocks and between the muscle bundles of the thighs.

I was puzzled to account for this extensive distribution of the gas until the work of Macklin, with experimental over-insufflation of the lungs in animals, was brought to my attention. Macklin insufflated the lungs of a cat by means of a catheter extending through the trachea, with blasts of air under pressures varying from 2 to 10 mm. of mercury. When the pressure was kept up for a sufficiently long time, he would find, at autopsy, in addition to a generalized subcutaneous emphysema, the presence of air in the mediastinum, about the aorta and the esophagus, and in both pleural cavities. There was also some air in the peritoneal cavity and in the sub-peritoneal structures, particularly large blebs of air collecting around the loose tissues of the perirenal fascia. By means of a serial section of the hardened specimens of the lungs he was able to demonstrate an interstitial emphysema about the perivascular sheaths.

Fig. 1. Roentgenograph showing infiltration of the gas through the various tissues of the neck, chest, and abdomen. *A*, Gas in the subcutaneous tissues and between the various muscle bundles of the neck. *B* and *D*, Mediastinal emphysema outlining the anterior border of the left lung and the left lobe of the thymus. *C*, Gas between the chest wall and the scapula. *E*, Partial left pneumothorax. *F*, Gas extending along the left border of aorta toward the diaphragm. *G* and *H*, Gas under the right and left domes of the diaphragm. *I*, Gas in the perirenal fascia outlining the kidneys. *J*, Coin within the stomach.

Macklin believes that the pathway followed by the gas in the over-distended portion of the

lung into the pleural cavity is not directly through the visceral pleura, as might be supposed, but by a more devious route through tiny openings in the alveoli into the interstitial tissues, hence along the perivascular sheaths of the lung into the mediastinum. The latter is gradually distended until rupture, usually of insignificant size, takes place at various points. Air then finds its way upward into the base of the neck, axillæ, and subcutaneous tissues of the trunk. Laterally, by rupture of the mediastinal pleura at the root of the lung, air enters the pleural cavities. If pressure is continued, the air dissects its way downward along the esophagus and aorta into the retroperitoneal tissues and perirenal fascia. Ultimately there is rupture of the peritoneum wth entrance of air into the peritoneal cavity.

The distribution of the gas in the experimental animals, as compared to that in our patient, offers such a striking parallelism as to leave little doubt that the pathways followed must have been the same. The problem that naturally suggests itself is whether or not pus, originating in the mediastinum or reaching it from the neck or lungs, might not, under certain conditions, follow a similar pathway. The other question to be considered is whether or not this might offer a new concept for the method of production of spontaneous pneumothorax rather than the older conception of direct rupture through the visceral pleura. Macklin and others are inclined to this view. It might be well to keep in mind, however, that what holds true for sudden over-insufflation of a normal lung need not hold true for chronic distention of a diseased lung. In a spontaneous pneumothorax brought about in this manner one must expect, of necessity, a preceding mediastinal emphysema and rupture. One would look, therefore, for a frequent occurrence of an associated emphysema of the neck and face in these cases as well as roentgenographic evidences of mediastinal emphysema associated with the pneumothorax. Either of these eventualities is, in my experience, uncommon. It would appear, therefore, that while spontaneous pneumothorax might, and possibly occasionally does, occur in this way, it is probably not the usual method of its production.

SUMMARY

Extensive surgical emphysema, pneumothorax, and pneumoperitoneum occurred in this case in the course of a closed-ether anesthesia. By analogy with animal experiments, the probable pathway followed by the gas is traced. Certain clinical implications suggested by the existence of this pathway are discussed.

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REPORT OF THE INTER-SOCIETY COMMITTEE FOR RADIOLOGY[1]

Your Inter-Society Committee was created to provide a national headquarters for all American radiology. Its function is to collect facts and information, to make this information available to members and local groups, and to offer advice and counsel when requested. Through this national office of American radiology, organized radiology is able to present its case to the American Medical Association, and the American Hospital Association, and other national agencies. Likewise, it is able to keep in touch with the activities of these agencies, to evaluate their effects upon radiology, and to interpret trends as they bear upon the welfare and progress of radiology.

There are several particular items of successful activity upon the part of the Committee as a whole, of the Executive Secretary as a fountain of factual and analytical information, and of the earnest and sincere work of the individual faculties inherent in the members of this Committee, that will be detailed later.

Your Inter-Society Committee wishes to acknowledge the splendid help that it has received from many individuals who have rallied to the support of our program in various situations and localities. The Committee acknowledges the importance of the radiologists chosen from each State as a human liaison with the problems of each State. Confidential and reliable information has helped the Committee to avoid errors of judgment and permitted us to form opinions and make decisions that have stood the test of the resulting experience.

The Advisory Committee, composed of the secretary and chairman of the executive council of each of the supporting societies, has aided materially in the determination of policies and has helped the Committee to develop a confidence in the merit of the program as it develops.

The Committee has sent the Executive Secretary to a number of cities where local radiologists have asked for help in excluding their services from hospital schemes of insurance and we are glad to report that these efforts have been successful in nearly every instance. We are not conscious of any complete defeat. We do know of innumerable victories. Details of such activities can be obtained from the Executive Secretary. They are too voluminous for this report.

At every opportunity we have urged and encouraged radiologists to improve their hospital arrangements. The Committee cannot force an individual hospital to revise an unfair contract with its radiologist but it can influence the local situations by calling attention to the resolutions of the Councils and House of Delegates of the American Medical Association that defend our ambitions to avoid the exploitation of radiological practice. The only pressure that organized medicine has at its disposal in defeating unfair practices and tactics by hospitals is through the approval listing of hospitals, internships, and residencies by the Council on Medical Education and Hospitals of the American Medical Association.

The Committee feels that real progress has been made in cementing the problems of radiology into the whole picture of the American medical profession. The healthy attitude of the House of Delegates and the splendid co-operation of the various Councils and the favorable action of the Board of Trustees and of the National Secretary, Dr. Olin West, are indications of the usefulness of this Committee to radiology. The actual facts of the proceedings at the San Francisco meeting of the American Medical Association have been printed in both the national journals. The Journal of the American Medical Association made these resolutions a matter of editorial comment.

The Committee has prepared, and this only through the capable Executive Secretary, two important documents for publication in the national journals. One is based upon "The Modern Hospital and its Relations to the Practice of Medicine." This is factual and carries citations to support the contentions. The ever-increasing activity of the hospitals and their national organizations and publications to establish medical practice by hospitals,

[1] Presented by E. H. Skinner, M.D., before the annual meeting of the American Roentgen Ray Society, Atlantic City, Sept. 22, 1938.

makes this an important contribution in support of our demand that radiology continue as medical and not hospital practice. The other article is titled, "What Is the Issue."[2] This is a more timely exposition of the most recent editorial opinion of hospital enthusiasts and furnishes the radiologists with ammunition and argument to controvert the specious claims of omni-service by hospitals. We direct your attention to these two items. They are to be followed by others. We would like to feel that the membership would support our requests for prompt printing of such informative articles by the journals controlled by our societies. We would not wish to sacrifice the most important scientific contributions but we do feel that the present stress and strain of the times warrants some stress upon the economic factors of radiological practice. We believe that members want these items. We would cordially invite an expression from the membership upon this point.

The Committee wishes to acknowledge the help and the cordial co-operation of various executive committeemen from the several societies in the development of standards of radiological practice. Such standards must be erected for the benefit of the Council on Medical Education and Hospitals if it is to carry out the instructions of the 1938 House of Delegates by imposing restrictions to influence hospitals that persist in exploiting any type of medical practice. This is a long-time problem and its solution seems to depend at this time upon the solidarity of the American Medical Association. If the influence of this parent organization is weakened or dissipated, our problems will be multiplied and perhaps stultified.

This report could be expanded into a volume if it attempted to detail the various and sundry activities of the committeemen and the Executive Secretary. This seems absolutely uncalled for and if any individual member wishes specific information, the Executive Secretary and the Committee will be only too glad to make the effort to completely satisfy that member. It now seems expedient to pass from the practical exposition of performance to the dreams and implications of the future.

The Committee believes that the following items represent the problems that threaten the welfare of the medical profession and radiological practice:

(1) The attitudes and practices of hospitals and the organized hospital world which tend to place radiology under the domination of a lay board of trustees, establishing it as a technical service to be rendered by hospitals instead of a professional service to be rendered by private physicians;

(2) The attempts to define radiology as a hospital service by including it among the hospital benefits offered in group insurance plans;

(3) The tendency for some hospitals to look upon the department of radiology as a legitimate source of revenue to pay losses sustained in other departments, thus depriving the radiologic department of a portion of its legitimate income;

(4) The attempts to dismember radiology and consequently destroy the specialty by dividing it into technical and professional stages;

(5) The increase in group and co-operative laboratories which supplant established and trained radiologists engaging in private practice;

(6) The threat of competition by the state through free diagnosis and treatment of cancer, and general diagnostic centers, thereby discouraging private enterprise and individual initiative by radiologists.

Let it be emphasized here that when the Committee approaches problems in medical economics it is not primarily concerned with the fact that some new development may curtail the income of an individual practitioner. It is, however, concerned with the fact that these developments may injure the growth of radiology, decrease the quality of the service to be offered to patients, and discourage the attraction of competent new matriculates to the field.

In appraising those problems which concern every practising radiologist it becomes necessary to first assemble some facts and evaluate some trends. The analysis of these facts and trends has occupied a large portion of the time of the Committee and its Secretary, Mr. Cahal, during this first year of its existence. To obtain facts we have distributed a questionnaire to the 1,500 members composing the four parent societies. The tabulation of the nearly 1,000 returns received represents a big task and, even with the help of the statistical department of the American Medical Association, we are not yet in a position to present to you at this time the results of this study. The

[2] RADIOLOGY, p. 491, October, 1938.

full report will be published within a short time. Also in pursuit of facts we have distributed numerous inquiries to our mailing list of state representatives. In addition, we have carefully studied all factual reports issued by other official bodies in the medical, hospital, and political fields in search of information which will help us to measure accurately the status and the problems of radiology.

To evaluate trends properly and thus to chart a proper course of action for the future, we have maintained a close association with the American Medical Association, the American Hospital Association, and other such agencies, for the purpose of observing actions relating to radiology and insofar as possible of assisting in the guidance of those actions. In anticipation of a federal sickness insurance program, which the most sanguine conservative must admit is a foregone certainty, we are making every effort to predict and to help establish the position of the radiologist in medical practice when, and if, such a program is instituted.

All these facts, in the form of bulletins, journals, reprints, and statistical surveys are being collected, indexed, and filed in our headquarters office. In the meantime we have established a focal point of contact between all organized radiology and the national associations representing other specialties, organized hospitals, and the American Medical Association. Illustrative of the value of such association is the splendid report issued April 30, 1938, in the *Journal of the American Medical Association* by the Board of Trustees of the Association, previous to the San Francisco session of the House of Delegates, and which set the stage for the encouraging stand taken by the American Medical Association during the meeting on behalf of radiology. The Committee, through its Secretary, was given the privilege of supplying information to assist in the preparation of that report. Its approval by the House of Delegates marked a decisive victory in the fight by radiologists to maintain their specialty against threats of domination and exploitation by the lay boards of trustees of hospitals. Its influence in the determination of developments will be felt for a long time to come.

The chief problem which has confronted the Committee during the past year has been in connection with hospital insurance. Here arose a question of supreme importance to the science and practice of radiology. Was radiology a technical service to be offered by incorporated hospitals as a part of hospital care on an annual premium basis, or was it a medical service to be provided by private physicians on a fee-for-service basis like other medical procedures? To repeated demands by this Committee and by the American Medical Association that medical services be excluded from hospital insurance schemes the American Hospital Association took an acrimonious stand and insisted that radiology was a part of hospital care and must be included as a part of hospital benefits in all such plans. Month after month their official journal has advanced principles to justify their contention that radiology is a service of, by, and for hospitals and as such must be included in the insurance plans.

While the record in combating this dangerous development is by no means perfect we are pleased to report that a successful defense has been waged. Several of the largest plans in existence to-day include radiology as a hospital service, but in the 30 or more plans adopted throughout the country during the past year only one or two has, to our knowledge, included radiology. The American Medical Association has taken a firm stand in support of the radiologist, the pathologist, the anesthetist, and others who object to a new development in hospital economics that will result in their specialty being taken over by the hospital. Throughout the past year the battle raged in Philadelphia between an adamant hospital council and a determined group of local radiologists and only within the past month were Philadelphia radiologists able to win their point. The Committee's Secretary spent much time in Philadelphia in assisting the local roentgen society. His services have been useful in similar fights in Denver, Kansas City, Michigan, Florida, and other localities where radiologists appealed for help in protecting their specialty against fundamental injury through the institution of hospital insurance schemes. Right now he is working with our members in Baltimore in an effort to obtain a correction of that plan and it is hoped that local groups in other communities who were forced to accept the wrong kind of a plan will take up the battle and, backed by the full support of the American Medical Association, insist upon a revision that will leave their profession in the same position as other medical

specialties. The credit for correction of the plans in California which originally included radiology belongs to a militant group in the Pacific Roentgen Society. These members have demonstrated what a positive program will do. The Inter-Society Committee could accomplish a great deal more if there were more of this type of aggressive local groups in all parts of the country.

The Secretary of the Committee, Mr. Cahal, has carried out his duties under the close supervision of the members of the Committee. While a large part of his time has been spent in travelling to various cities at the request of local roentgen groups it has been necessary for him to dispose of a large amount of work through the headquarters office. In addition to routine details and frequent conferences with councils of the American Medical Association and other agencies headquartering in Chicago, daily inquiries are received at our office from hospitals, medical societies, member radiologists, and social agencies calling for study and reply. Any such inquiry which involves a question of policy is referred to members of the Committee before action and if of sufficient importance it is in turn referred to our Advisory Committee, composed of the secretaries and Chairmen of Executive Committees of the four participating societies.

During the past year the Secretary has made one or more trips to the following places, either to attend a meeting or offer assistance; Philadelphia, New York, Pittsburgh, Boston, Washington, Baltimore, Atlantic City, Denver, Los Angeles, San Diego, San Francisco. He has sat in conferences with medical society councils and addressed medical societies in Michigan, Illinois, Indiana, Missouri, Pennsylvania, and Colorado. Soon after starting his duties he visited Detroit, Cleveland, and other localities which offered convenient stopping places on other official trips. Next month he will visit Texas for a meeting with the state radiological society.

The editors of both your journal and of the *American Journal of Roentgenology and Radium Therapy* have generously agreed to set aside a regular department for monthly reports and articles by or sponsored by the Committee. This, we feel, is a more desirable and a less expensive way of keeping in contact with the members than by publishing a bulletin of our own. Through these regular reports we hope to keep every member thoroughly aware of important developments and to maintain a concert of opinion among the members of our own profession.

If it is to be properly represented in the profound changes taking place in the social and economic phases of medical practice, the profession of radiology must be thoroughly awake, strongly unified, and aggressively articulate. We feel that radiologists have these three things in the program of the Inter-Society Committee.

RADIOLOGICAL SOCIETIES IN THE UNITED STATES

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

CALIFORNIA

California Medical Association, Section on Radiology.—Chairman, John D. Lawson, M.D., 1306 California State Bldg., Sacramento; *Secretary,* Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles. Meets annually with California Medical Association.

Los Angeles County Medical Association, Radiological Section.—President, John F. Chapman, M.D., 65 N. Madison Ave., Pasadena; *Vice-president,* E. N. Liljedahl, M.D., 1241 Shatto St.; *Secretary,* Merl L. Pindell, M.D., 678 South Ferris Ave.; *Treasurer,* Henry Snure, M.D., 1414 Hope Street. Meets every second Wednesday of month at County Society Building.

Pacific Roentgen Club.—At its recent Annual Meeting at Pasadena, the following officers were elected for the ensuing year: *Chairman,* Lyell C. Kinney, M.D., San Diego; *Member of the Executive Committee,* Irving S. Ingber, M.D., San Francisco; *Secretary-Treasurer,* L. Henry Garland, M.D., Suite 1739, 450 Sutter Street, San Francisco. The other members of the Executive Committee are: Lowell S. Goin, M.D., Los Angeles, and Alfred C. Siefert, M.D., Oakland.

San Francisco Radiological Society.—Secretary, L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

COLORADO

Denver Radiological Club.—President, John S. Bouslog, M.D., 246 Metropolitan Bldg.; *Vice-president,* Sanford Withers, M.D., 304 Republic Bldg.; *Secretary,* Ernst A. Schmidt, M.D., Colorado General Hospital; *Treasurer,* H. P. Brandenburg, M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Chairman, Ralph T. Ogden, M.D., 179 Allyn St., Hartford; *Vice-chairman,* Francis M. Dunn, M.D., 100 State Street, New London; *Secretary-Treasurer,* Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

FLORIDA

Florida State Radiological Society.—President, H. O. Brown, M.D., 404 First National Bank Bldg., Tampa; *Vice-president,* H. B. McEuen, M.D., 126 W. Adams St., Jacksonville; *Secretary-Treasurer,* J. H. Lucinian, M.D., 168 S. E. 1st St., Miami.

GEORGIA

Georgia Radiological Society.—President, James J. Clark, M.D., Doctors Bldg., Atlanta; *Vice-president,* William F. Lake, M.D., Medical Arts Bldg., Atlanta; *Secretary-Treasurer,* Robert C. Pendergrass, M.D., Prather Clinic, Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—President, David S. Beilin, M.D., 411 Garfield Ave.; *Vice-president,* Chester J. Challenger, M.D., 3117 Logan Blvd.; *Secretary-Treasurer,* Roe J. Maier, M.D., 7752 Halsted St. Meets second Thursday of each month, September to May, except December.

Illinois Radiclogical Society.—President, Cesare Gianturco, M.D., 602 W. University Ave., Urbana; *Vice-president,* Fred H. Decker, M.D., 802 Peoria Life Bldg., Peoria; *Secretary-Treasurer,* Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur. Meetings quarterly by announcement.

Illinois State Medical Society, Section of Radiology.—The next meeting will be May 2, 3, 4, 1939, to be held in Rockford. The officers of the Section for the coming meeting are Harry B. Magee, M.D., of Peoria, *Chairman,* and Warren W. Furey, M.D., 6844 Oglesby Ave., Chicago, *Secretary.*

INDIANA

Indiana Roentgen Society.—President, Stanley Clark, M.D., 108 N. Main St., South Bend; *President-elect,* Juan Rodriguez, M.D., 2903 Fairfield Ave., Fort Wayne; *Vice-president,* A. C. Holley, M.D., Attica; *Secretary-Treasurer,* Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

MAINE

See New England Roentgen Ray Society.

MARYLAND

Baltimore City Medical Society, Radiological Section. Chairman, Marcus Ostro, M.D., 1810 Eutaw Place; *Secretary,* H. E. Wright, M.D., 101 W. Read St., Baltimore. Meetings second Tuesday of each month.

MASSACHUSETTS

See New England Roentgen Ray Society.

MICHIGAN

Detroit X-ray and Radium Society.—President, E. W. Hall, M.D., 10 Peterboro Street; *Vice-president,*

Sam W. Donaldson, M.D., 326 North Ingalls St., Ann Arbor; *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society Bldg.

Michigan Association of Roentgenologists.—President, E. R. Witwer, M.D., Harper Hospital, Detroit; *Vice-president*, D. W. Patterson, M.D., 622 Huron Street, Port Huron; *Secretary-Treasurer*, C. K. Hasley, M.D., 1429 David Whitney Bldg., Detroit.

MINNESOTA

Minnesota Radiological Society.—President, Walter H. Ude, M.D., 78 S. 9th St., Minneapolis; *Vice-president*, Leo G. Rigler, M.D., University Hospitals, Minneapolis; *Secretary-Treasurer*, Harry Weber, M.D., 102 Second Ave., S. W., Rochester. Meetings quarterly.

MISSOURI

The Kansas City Radiological Society.—President, L. G. Allen, M.D., 907 N. 7th St.. Kansas City, Mo.; *Secretary*, Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—President, Joseph C. Peden, M.D., 634 N. Grand Blvd.; *Secretary*, W. K. Mueller, M.D., 607 N. Grand Blvd. Meetings fourth Wednesday of each month.

NEBRASKA

Nebraska Radiological Society.—President, E. W. Rowe, M.D., 128 N. 13th St., Lincoln; *Secretary*, D. Arnold Dowell, M.D., 117 S. 17th St., Omaha. Meetings first Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *President*, Frank E. Wheatley, M.D., 520 Beacon St., Boston; *Secretary*, E. C. Vogt, M.D., 300 Longwood Ave., Boston. Meetings third Friday of each month from October to May, inclusive, usually at Boston Medical Library.

NEW HAMPSHIRE

See New England Roentgen Ray Society.

NEW JERSEY

Radiological Society of New Jersey.—President, Milton Friedman, M.D., Newark Beth Israel Hospital, Newark; *Vice-president*, P. S. Avery, M.D., 546 Central Ave., Bound Brook; *Secretary*, W. James Marquis, M.D., 198 Clinton Ave., Newark; *Treasurer*, James Boyes, M.D., 744 Watchung Ave., Plainfield. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

NEW YORK

Brooklyn Roentgen Society.—President, Albert Voltz, M.D., 115–120 Myrtle Avenue, Richmond Hill; *Vice-president*, A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts., Brooklyn; *Secretary-Treasurer*, E. Mendelson, M.D., 132 Parkside Ave., Brooklyn. Meetings first Tuesday in each month at place designated by president.

Buffalo Radiological Society.—President, Walter Mattick, M.D., 101 High St.; *Vice-president*, Chester Moses, M.D., 333 Linwood Ave.; *Secretary-Treasurer*, J. S. Gian-Franceschi, M.D., 610 Niagara Street. Meetings second Monday evening each month.

Central New York Roentgen-ray Society.—President, W. E. Achilles, M.D., 60 Seneca St., Geneva; *Vice-president*, M. T. Powers, M.D., 250 Genesee St., Utica; *Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings held in January, May, and October as called by Executive Committee.

Long Island Radiological Society.—President, Samuel G. Schenck, M.D., Brooklyn; *Vice-president*, G. Henry Koiransky, M.D., Long Island City; *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn; *Treasurer*, Louis Goldfarb, M.D., 608 Ocean Ave., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—President, Raymond W. Lewis, M.D., 321 E. 42nd St., New York City; *Vice-president*, Henry K. Taylor, M.D., 667 Madison Ave., New York City; *Secretary*, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains; *Treasurer*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City; *Member of Executive Committee*, E. Forrest Merrill, M.D., 30 W. 59th St., New York City. Meetings third Monday evening each month at Academy of Medicine.

Rochester Roentgen-ray Society.—Chairman, Joseph H. Green, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

Society of Radiological Economics of New York.—President, Albert L. Voltz, M.D., 115–120 Myrtle Ave., Richmond Hill; *Vice-president*, M. M. Pomeranz, M.D., 911 Park Ave., New York City; *Secretary*, W. F. Francis, M.D.; *Treasurer*, Theodore West, M.D., United Hospital, Port Chester. Meetings first Monday evening each month at McAlpin Hotel.

NORTH CAROLINA

Radiological Society of North Carolina.—President, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

OHIO

Cleveland Radiological Society.—President, North W. Shetter, M.D., Lakewood City Hospital, Lakewood; *Vice-president,* John Heberding, M.D., St. Elizabeth's Hospital, Youngstown; *Secretary-Treasurer,* Harry Hauser, M.D., Cleveland City Hospital, Cleveland. Meetings at 6:30 P.M. at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*President,* B. M. Warne, M.D., Doctors Building, Cincinnati; *Secretary-Treasurer,* Justin E. McCarthy, M.D., 707 Race St., Cincinnati, Ohio. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—President, Charles S. Caldwell, M.D., 520 S. Aiken Ave., Pittsburgh; *First Vice-president,* Thomas L. Smyth, M.D., 111 N. 8th St., Allentown; *Second Vice-president,* Reuben G. Alley, M.D., Western Pennsylvania Hospital, Pittsburgh; *Secretary-Treasurer,* Lloyd E. Wurster, M.D., 416 Pine St., Williamsport; *President-elect,* Louis A. Milkman, M.D., 212 Medical Arts Bldg., Scranton; *Editor,* William E. Reiley, M.D., Clearfield. Annual meeting, May, 1939. Exact date and place to be decided.

Philadelphia Roentgen Ray Society.—President, Thomas P. Laughery, M.D., Germantown Hospital; *Vice-president,* Elwood E. Downs, M.D., Jeans Hospital, Fox Chase; *Secretary,* Barton H. Young, M.D., Temple University Hospital; *Treasurer,* R. Manges Smith, M.D., Jefferson Hospital. Meetings first Thursday of each month from October to May, Thompson Hall, College of Physicians, 19 S. 22nd St., 8:15 P.M.

The Pittsburgh Roentgen Society.—President, William B. Ray, M.D., 320 E. North Avenue, N. S. Pittsburgh; *Secretary,* Harold W. Jacox, M.D., 4800 Friendship Ave. Meetings held second Wednesday of each month at 4:30 P.M., from October to June at various hospitals designated by program committee.

RHODE ISLAND

See New England Roentgen Ray Society.

SOUTH CAROLINA

South Carolina X-ray Society.—President, Robert B. Taft, M.D., 105 Rutledge Ave., Charleston; *Secretary-Treasurer,* Hillyer Rudisill, Jr., M.D., Roper Hospital, Charleston. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee State Radiological Society.—President, S. S. Marchbanks, M.D., 508 Medical Arts Bldg., Chattanooga; *Vice-president,* Steve W. Coley, M.D., Methodist Hospital, Memphis; *Secretary-Treasurer,* Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—President, R. G. Giles, M.D., Medical Arts Bldg., San Antonio; *President-elect,* Jerome H. Smith, M.D., Shannon West Texas Memorial Hospital, San Angelo; *First Vice-president,* C. F. Crain, M.D., 416 Chaparral St., Corpus Christi; *Second Vice-president,* M. H. Glover, M.D., 904 8th St., Wichita Falls; *Secretary-Treasurer,* G. D. Carlson, M.D., 3121 Bryan St., Dallas. Meets annually. San Antonio is place of meeting, Oct. 22, 1938.

VERMONT

See New England Roentgen Ray Society.

VIRGINIA

Radiological Society of Virginia.—President, Fred M. Hodges, M.D., 100 W. Franklin St., Richmond; *Vice-president,* L. F. Magruder, M.D., Raleigh and College Aves., Norfolk; *Secretary,* V. W. Archer, M.D., University of Virginia Hospital, Charlottesville.

WASHINGTON

Washington State Radiological Society.—President, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Secretary,* T. T. Dawson, M.D., Fourth and Pike Bldg., Seattle. Meetings fourth Monday of each month at College Club.

WISCONSIN

Milwaukee Roentgen Ray Society.—Secretary, S. A. Morton, M.D., Columbia Hospital, Milwaukee. Meets monthly on first Friday.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

THE RESPONSIBILITY OF THE AMERICAN BOARD OF RADIOLOGY FOR SETTING UP AND MAINTAINING STANDARDS IN RADIOLOGICAL EDUCATION[1]

We must remember that, primarily, the American Board of Radiology was organized to examine and certify to the competence of physicians who profess to specialize in radiology. Nevertheless, I think it will be agreed that the American Board of Radiology and radiologic standards are practically synonymous, for if the Board conducts examinations as they should be conducted it will automatically raise the standards of radiologic practice.

On the other hand, the Board cannot raise the standards of radiologic practice beyond the capacity of the teaching facilities that we have in this country. To emphasize that point I shall quote from the recommendations for graduate training in radiology that were adopted by the Board in Atlantic City last Spring. Under "B," the heading now reads: "Special training, to be effective January 1, 1940," but to-day the date has been changed to January 1, 1942. The requirement follows: "A period of study, after the internship, of not less than three years in an institution or radiologic department recognized by the same Council (the Council on Medical Education and Hospitals of the American Medical Association) and the Board of Radiology as competent to provide a satisfactory training in the field of radiology, or equivalent training acceptable to the Board."

Now in order to arrive at a conclusion as to what constitutes a satisfactory radiologic training and to compile and publish a list of those offering such training the members of the Board feel that we must make a survey of the radiologic training that is now available in this country. There is now just off the press a registry of diplomates of the American Board of Radiology. Every diplomate of the Board will receive a copy of this registry within the next few weeks. It will be accompanied by a printed notice that the Board is attempting to compile a list of institutions or individual teachers offering graduate or post-graduate training in radiology, and that a questionnaire concerning the information desired will be sent on request. The distinction between graduate and post-graduate training that has been adopted by the Advisory Board for Medical Specialties and, as I understand, by the Council on Medical Education and Hospitals of the American Medical Association, is substantially as follows: By "graduate training" is meant a course of instruction over a long and continuous period of time, that is, from one to three years, while post-graduate education or post-graduate courses apply to shorter review or "refresher" courses of from a week to a few months such as are offered to physicians who have already had some experience or training in the specialty.

It is hoped and expected that all such institutions or independent instructors will ask for questionnaires. When they are filled out and returned they will furnish information to the Board as to the character of courses offered, type of instruction, teaching personnel, and the time devoted to various subjects, including physics, pathology and other basic sciences. From the total of replies the Board will obtain a definite idea as to the quality and amount of graduate training that is available in this country. Those who heard Dr. Holmes' Carman Lecture[2] at the International Congress of Radiology will realize, I am sure, that it is a very serious problem as to whether or not we actually have sufficient facilities for training an adequate number of radiologists.

After reviewing the questionnaires the Board may feel that it can give suggestions or advice to those offering training and thus help to improve the quality and extent of instruction in some of the institutions.

[1] Part of a symposium on radiologic training presented at the Eighth Annual Conference of the American College of Radiology, Chicago, Feb. 13, 1938.

[2] Published in RADIOLOGY, **29**, 652–659, December, 1937.

There is another important function that we feel the Board can perform in raising the standards of radiologic training. For almost four years, since 1934, the Board has been examining applicants, and in that time has certified more than 1,100. Considering that large number, with more to come, I think it will readily be appreciated that the Board has some valuable data, and in the Secretary's office we are now in process of canvassing the data. For example, we can go through the files of candidates examined and select those applicants who were trained, let us say, at Institution X, perhaps fifteen or twenty in number. That number is sufficiently large to enable us to draw some conclusions as to the quality of training given by Institution X. On reviewing the records of these candidates in various branches of radiology it may become apparent that a considerable proportion of the applicants have not made too good a showing in gastro-intestinal roentgenology. If that is the case there is something wrong in the way that gastro-intestinal roentgenology is being taught at Institution X, and the Board can be of definite help to the institution by pointing out the fact. Likewise, the trainees of some other school may fail to make a satisfactory showing in pathology or in physics and this information will be available to the institution concerned. I can assure all of you who want to know how the applicants you have trained are getting along with their examinations that we shall be glad to furnish you with the results on file in the Secretary's office.

It seems to me that in these ways the Board can probably contribute a great deal toward raising the standards of radiology, for those standards can be raised by improving methods of training. It goes without saying that the Board must conduct itself in a way that will not leave it open to criticism. I mean that our examinations must be rigid but fair, and I assure you that we are making every effort to keep them both rigid and fair.

B. R. KIRKLIN, M.D.

ANNOUNCEMENT

PRESIDENT'S INVITATION TO THE ANNUAL MEETING

We wish to extend to all radiologists a cordial invitation to attend our Annual Meeting, Nov. 27–Dec. 2, in Pittsburgh. The headquarters will be at the Hotel William Penn.

The program has been arranged for general sessions during the mornings and separate sessions of diagnosis and therapy during the afternoons, which will permit of a more detailed discussion of the various subjects. The Clinics, which have always been a popular and important part of our programs, will be continued. A new feature this year will be the "Refresher Courses" on Sunday, all day, and Monday morning. These will be worth your attention.

The Carman Lecture will be given this year by William C. MacCarty, M.D., who is well known to all of us. Dr. MacCarty will discuss Cancer of the Stomach and his discussion of the ulcer-cancer relationship will be of particular interest to everyone.

In addition, we hope to have some of our usual delightful social occasions which always add a great deal of pleasure to our meetings.

HOWARD P. DOUB, M.D.
President of the Radiological Society of North America

COMMUNICATIONS

NORTHERN SOCIETY FOR MEDICAL RADIOLOGY

The Editor has received the following communication from Dr. Albert Soiland, of Los Angeles, California:

"The annual meeting of the Northern Society for Medical Radiology was held in Copenhagen, Denmark, on June 28, 29, 30, of this year. Approximately 200 delegates were assembled from Denmark, Norway, Sweden, and Finland. Dr. Swanson, of New York, and I were the only Americans present.

"Both the diagnosis and treatment of cancer were ably discussed by such men as Bakke, Dale, Bull Englestad, of Norway; Jönsson, Heyman, Edling, Wulff, of Sweden, and

Bichel, Nielson, and Kirketerp, of Denmark. A great deal of attention was paid to x-ray treatment of specific and non-specific arthritis, peri-arthritis, and neuritis, by Baastroup and Moltke of Denmark; Sandstrom, Kahlmeter, Renck and Westermark of Sweden; Frimann and Dale of Norway, and Mustakalleo of Finland.

"Roentgen diagnosis in its wider ramifications was illustrated in a most interesting and instructive manner, notably by Akerlund and Westermark of Sweden, and Wordenstoft, Westergaard, Licht, Christiansen, and Nörgaard of Denmark.

"The modernized Finsen Institute, since my first visit there in 1905, has a remarkable record of achievement. From a modest beginning, Nils Finsen began the eradication of lupus vulgaris from Europe in 1900. What had been accomplished by him up to the moment of his untimely death, and by his followers up to the present time, was strikingly illustrated before the general assembly by the Institute's present leaders, Lomholt and Chievitz.

"Space does not allow a reference to the essays of all the delegates in attendance, but it was a well balanced program and well worth my journey of six thousand miles. This Ninth Annual Congress was under the direction of President P. Flemming Möller and his efficient local secretary, Jens Nielson, of Denmark.

"The General Secretary of the Congress was Carl Sandstrom of Sweden. The meetings were held at the Government Hospital (Rikshospitalet) at Copenhagen where the ample amphitheatre was well provided with effective projection apparatus for all types of slides, films, and illustrations. A feature was the motor-driven mechanism for shutting out all outside light and maintaining ventilation.

"Since the Hospital is located at the city's outskirts, the management served, gratis, at noon each day, breakfast 'Frokost' to the Danes. This consisted of an excellent hot meal accompanied by a bountiful cold table —and the Swedes have a name for it, 'Smorgas,' literally translated 'buttered goose.' In short, it is a regular American warm meal, plus an endless variety of cold cuts—meat, fish, vegetables, cheese, and fruit, garnished with artistic skill into a glorified maze of hors d'oeuvres. Naturally, the delegates were enthusiastic over this display of hospitality and voted three rousing cheers for their gracious hosts.

"During the sessions, your scribe presented an article, with slides, entitled 'Certain Aspects of Supervoltage X-ray Therapy with Comments.'"

GERMAN ROENTGEN SOCIETY

"The 1938 meeting of the German Roentgen Society was held in Munich, July 3 to 7, inclusive. The Society's meetings took place in the 'Kongresshalle des Ausstellungsparks,' meaning, 'The Lecture Hall at Exposition Park.' The building was new, commodious, and admirably constructed to serve large groups for lectures, instruction, and assemblies up to four or five thousand. Between the lectures one could ramble around the park or visit many interesting exhibits in the various buildings. Professor Karl Frik of Berlin, was President, and Dr. G. A. Weltz of Munich, Secretary General.

"Several noted medical guests were invited to sit at the administration table from time to time, and your scribe had the honor to direct proceedings during one of the afternoon sessions. My application for place on this program arrived too late to be included, and the program was already overcrowded, but I was, nevertheless, permitted to show some slides and make a few remarks on the management of cancer. Approximately 700 radiologists, surgeons, pathologists, and physicists were in attendance, and the program was excellent, with a little overbalance on highly technical subjects. There were a few delegates present from the various Scandinavian countries, also Austria, Hungary, Jugoslavia, Czechoslovakia, Switzerland, and Italy. No French nor English, and your scribe was the only American, the majority being, of course, Germans.

"The display of x-ray, electrical, and physical apparatus was impressive and a new type German million-volt x-ray generator elicited a great deal of interest. The social program was varied and ample."

A NOTE OF CORRECTION

The authors of "Osseous Growth and Development," which was published in the October issue, desire to state that, on page 442, the heading, ,'Boys—radius—head, advanced 6 mos.," should read, "Boys—radius—head, a dvanced 46 mos." The mistake in the artist's lettering was not discovered until the drawing had been printed.

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

MALIGNANT TUMORS OF THE SKELETAL MUSCLES, FASCIÆ, JOINT CAPSULES, TENDON SHEATHS, AND SEROUS BURSÆ. By GUNNAR JÖNSSON. Supplement XXXVI to *Acta Radiologica* A volume of 304 pages. Published by P. A. Norstedt & Son, Stockholm, 1938. Price: 20: Swed. cr.

A HANDBOOK OF ROENTGEN AND RADIUM THERAPY. By A. J. DELARIO, B.A., M.D., Radiologist, St. Joseph's Hospital, Paterson, N. J., and Community Hospital, Montclair, N. J. A volume of 362 pages illustrated with numerous engravings, graphs, and tables. Published by F. A. Davis Company, Philadelphia, 1938. Price: $8.00.

BOOK REVIEW

RÖNTGENATLAS DER ASBESTOSE DER LUNGEN (Roentgen Atlas of Pulmonary Tuberculosis). By DR. ERICH SAUPE, from the Radiological Department of the Rudolf Hess Hospital, Dresden, Germany. A volume of 99 pages, with 52 illustrations. Published by Georg Thieme, Leipzig, 1938. Price: R.M. 21.50.

Dr. Saupe's well-organized book on asbestosis presents the subject matter in ten chapters. In the first, which is historical, he notes that medically, the disease has been recognized since about 1900. The second chapter contains beside the geology, mineralogy, and technology of the condition, detailed and careful discussion of the chemistry, and the author's belief that not silicic acid but the silicates are responsible for asbestosis. He also goes into the geographic localities and how, and by approximately how many persons, asbestos is mined.

In the third major division of the book, the author describes the pathologic anatomy of pulmonary asbestosis. This is characterized by more or less diffuse fibrosis of lung tissue (in contradistinction to the nodular or tumorous appearance of silicosis) which increases from above downward, and which may cause pulmonary epithelium to be transformed into cube-shaped or cylindrical cells, and occasionally produces desquamative inflammation. The lymph glands may show fibrous induration.

The fourth chapter, on the clinical handling of the disease, is itself divided into (A) the patient's history, (B) objective clinical findings, (C) complications, (D) x-ray findings and differential diagnosis, and (E) asbestos needles and asbestos bodies. In subdivision (D), the author outlines his technic and differentiates the roentgen appearance of three stages and a pre-stage. He stresses the need for differential diagnosis of asbestosis and silicosis, silicatosis and tuberculosis, and gives his critique for so doing.

The remaining subject matter in the book is amply explained by the chapter titles, thus: 5, Dependence of Asbestosis on Time Worked in Asbestos Mines; 6, Prognosis; 7, Therapy; 8, Disposition (of Patient), Medical Prophylaxis, and Technical Precautions; 9, Asbestosis as Recompensable Industrial Disease, and 10, Bibliography.

There is ably developed, competent handling of the subject, and the book is a good one, of especial value to the roentgenologist interested in pulmonary or industrial diseases. According to Dr. Saupe, asbestosis is not a silicosis but a silicatosis, and he does not agree with Sparks (RADIOLOGY, **17,** 1249, December, 1931) that in it "small calcareous nodules are scattered throughout the lower zone." The illustrations are well done and can be studied to advantage, although it must be remembered that without other corroborative proofs of the disease, the roentgenogram cannot be considered conclusive for diagnostic purposes.

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

Adenoids 639
Apparatus 639
Backache 640
Bone Diseases (Diagnosis) 641
Calcinosis 641
Cancer (Diagnosis) 642
Cancer (Therapy) 643
Contrast Media 643
Diverticulitis 643
Foreign Bodies 644
Gastro-intestinal Tract (Diagnosis) 644
Heart and Vascular System 644
Hernia 644
Inflammatory Diseases 645
The Kidneys 645
The Lungs 646
Maxillary Fractures 647
Protection 647
Sarcoma 647
Skin Diseases 647
The Stomach 648
The Thyroid 649
Tuberculosis, Pulmonary 649
Viscera, Transposition 650

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S. R. Beatty, M.D., of Denver, Colo.
W. R. Brooksher, M.D., of Fort Smith, Ark.
J. J. Clark, M.D., of Atlanta, Ga.
Benjamin Copleman, M.D., of Perth Amboy, N. J.
I. I. Cowan, M.D., of Milwaukee, Wis.
W. H. Gillentine, M.D., of New Orleans, La.
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Ernst A. Schmidt, M.D., of Denver, Colo.
Charles G. Sutherland, M.D., of Rochester, Minn.
J. E. Whiteleather, M.D., of Memphis, Tenn.

ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

Albright, Fuller. Changes Simulating Legg-Perthes Disease (Osteochondritis Deformans Juvenilis) Due to Juvenile Myxedema: Report of a Case 641
Amberson, J. Burns, Jr. The Lasting Cure of Early Pulmonary Tuberculosis 649
Anton, Günther. The Basis, Limits, and Toleration of Endobronchial Iodized Oil 643
Belot, J. A New Roentgen Therapy Tube for High Intensities with an External Anticathode Constructed by the "Compagnie Generale de Radiologie." 639
Bernstedt, Ragnar. Secondary Radiation from Protective Walls in Hard Roentgen Radiation 647
Blitz, Martin, *with* Luft, Fritz, jt. auth. 639
Burgos, Carlos. Intra-arterial and Intra-cardiac (Left Ventricle) Injections 644
Busch, K. F. B. Familial Disseminated Osteosclerosis 641
Cottenot, P. New Procedure for Localization of Foreign Bodies in the Eye 644
Daniel, Gaston. Optimum Effective Doses in Roentgen Therapy of Inflammatory Affections 645
Delort, Maurice. Appearance of a Lesion in October, 1937, in a Patient Observed since October, 1930, because of a Gastritis Syndrome: Radiologic Signs and Surgical Verification 642
Denier, A. The Measurement of Impedance in Edema 640
Ducuing, J. The Geneva Classification of Carcinomas of the Collum Uteri 642
Eiman, John E., *with* Randall, Alexander, jt. auth. 645
Eschbach, Heinrich. The Direct Demonstration of Bronchial Stenosis in Bronchial Carcinoma 642
Idem: The Problem of the Filter Equivalent of the Wall of a Ray-proof X-ray Tube 639
Finney, G. A., *with* Pusitz, M. E., jt. auth. 641
Gibert, Paul. Roentgen Therapy of Adenoid Tissues 639
Glanzmann, E. Larsen-Johansson's Disease of the Patella and Schlatter's Disease 641
Göbel, A., *with* Hamann, A., jt. auth. 643
Goldmann, H. The Exact Localization of Marginal Intra-ocular Foreign Bodies 644
Gouley, Benjamin. The Evolution of the Parenchymal Lung Lesions in Rheumatic Fever and Their Relationship to Mitral Stenosis and Passive Congestion 646
Gravier, *with* Rebattu, jt. auth. 642
Guarini, Carlo. Ossification of the Internal Paracondyle of the Femur (Pellegrini's Disease) 641
Gunby, Paul C. Solitary Congenital Pulmonary Cyst: Report of One Case 646
Hagenbach, E. Stereoscopic Roentgenograms 639
Hamann, A., and Göbel, A. Six-year End-results in the Treatment of Uterine Carcinoma in the St. George General Hospital in Hamburg 643
Harbin, Maxwell. Low Back Pain with Sciatic Radiation: Recent Advances in Treatment 640
Hefke, H. W. Radiation Therapy in Benign and Malignant Diseases of the Ear, Nose, and Throat 645
Hemmeler, G. Lipiodol Emboli in the Brain and Lungs after Hysterosalpingography 643
Hsu, C. L., *with* Wang, S. H., jt. auth. 650
Kaufmann, W. What Kind of Roentgen Examination of the Digestive Organs can the General Practitioner Commend? 644
Kulchar, George V., *with* Liljencrantz, Eric, jt. auth. 647

LAHEY, FRANK H. Complete Removal of the Stomach for Malignancy: Report of Five Surgically Successful Cases..... 648
LEBERMAN, PAUL R., *with* RANDALL, ALEXANDER, jt. auth..... 645
LILJENCRANTZ, ERIC, and KULCHAR, GEORGE V. Clinical Management of Skin Cancer..... 647
LUCK, J. V., *in collaboration with* STEINDLER, ARTHUR..... 640
LUFT, FRITZ, and BLITZ, MARTIN. Modern Darkroom Illumination for Roentgen Laboratories..... 639
MCGLASHAN, J. E. Lupus Vulgaris and the Significance of Certain Non-specific Eruptions in Relationship to Tuberculosis..... 648
MCREYNOLDS, I. S. Osteolytic Osteogenic Sarcoma, with a Report of Eight Five-year Survivals..... 647
MAJOR, GLENN. Kirschner Traction in the Treatment of Maxillary Fractures..... 647
MEYER, ANDRÉ. Indications, Technic, and Results of Radiotherapy of Inflammatory Conditions of the Tonsils and Nasopharynx..... 645
NEGRU, D. Roentgen Therapy of Basedow's Disease..... 649
NIXON, EDWIN A. Diverticulitis..... 643
OWEN, A. K., *with* PUSITZ, M. E., jt. auth..... 641
PIERGROSSI, ALDO. Hepato-diaphragmatic Interposition of Loops of Small Intestine and its Relationship to Other Affections (Gastrectasia, Pneumatosis Cystica, etc.)..... 644
POWERS, ROBERT A. Rotating Anode X-ray Tube..... 639
PRICKETT, CLARK P., *with* ROOT, JOSEPH C., jt. auth..... 644
PUSITZ, M. E., OWEN, A. K., and FINNEY, G. A. Calcinosis Cutis..... 641
RANDALL, ALEXANDER, EIMAN, JOHN E., and LEBERMAN, PAUL R. Studies on the Pathology of the Renal Papilla..... 645
REBATTU, GRAVIER, and SPRECHER. Pseudo-esophageal Type of Cancer of the Bronchus. 642
ROOT, JOSEPH C., and PRICKETT, CLARK P. Diaphragmatic Hernia..... 644
SEMB, C. Thoracoplasty with Extrafascial Apicolysis..... 646
SERRET. Herpes and Physiotherapy..... 648
SKINNER, EDWARD H. Mucosal Pattern Technic and Kymographic Records of the Esophagus and Stomach..... 648
SMITH, FRANK R. Palliation of Cancer in Gynecology..... 643
SPRECHER, *with* REBATTU, jt. auth..... 642
STEINDLER, ARTHUR *in collaboration with* LUCK, J. V. Differential Diagnosis of Pain Low in the Back: Allocation of the Source of Pain by the Procaine Hydrochloride Method..... 640
STEVENS, WILLIAM E. Roentgenological Examination of the Kidney, with Special Reference to Backflow and Injuries Associated with Retrograde Pyelography..... 646
THORAEUS, R. The Amount of Off-focus Radiation in Beams from Various Types of Roentgen Tubes..... 639
TICE, G. M. Roentgen Kymographic Study of the Heart..... 644
TYAU, CHRISTY Y. D. Congenital Dextrocardia with Complete Transposition of Viscera: Report of Case..... 650
WANG, S. H., HSU, C. L., and WU, C. Roentgenologic Study of Isolated Form of Pulmonary Tuberculosis..... 650
WU, C., *with* WANG, S. H., jt. auth..... 650

ADENOIDS

Roentgen Therapy of Adenoid Tissues. Paul Gibert. Jour. de radiol. et d'électrol., **22,** 19–22, January, 1938.

Inflammation and hypertrophy of the adenoid tissues of the ring of Waldeyer play an important part in the pathology of infancy. Inflammation and hypertrophy are frequently components of a vicious circle. The effects are mechanical (obstructive) and infectious (local and distant).

The usual treatment is surgical ablation. Frequently this is unsuccessful, particularly if involvement is general throughout the nasopharynx. Often there is recurrence. There are many contra-indications to surgery—infection, youth of the patient, hemorrhagic syndromes, poor general condition, etc. In these cases, the extreme radiosensitivity of the adenoid tissues makes roentgen therapy efficacious and the method of choice. In addition, the favorable effect of roentgen therapy upon inflammatory conditions frequently renders this method of treatment preferable and available when surgery is contra-indicated. The author's technic: radiations of moderate or high penetration filtered through 10 mm. Al or 0.5 mm. Cu, F.S.D. 23 or 30 cm., fields covering the pharyngeal and cervical regions from the zygomatic arch to the clavicle. Doses of 100 r are given to each side two, three, or rarely four times, the series taking 15 to 21 days. The author believes this dosage may be too low. There is no danger, with these doses, of injury to normal tissues or of interference with growth.

S. R. Beatty, M.D.

APPARATUS

The Problem of the Filter Equivalent of the Wall of a Ray-proof X-ray Tube. H. Eschbach. Strahlentherapie, 1938, **62,** 287.

The author determined the filter equivalent of the wall of a Metalix deep therapy tube. He found that at 80 kv. it is equivalent to 3.2 mm. Al or 0.109 mm. Cu. At 180 kv., this changes to 4.25 mm. Al or 0.193 mm. Cu. The practical importance of these findings for the choice of the adequate treatment filter and the effect on the penetration of the radiation is discussed. It is recommended that manufacturers indicate not only the maximum potential and current for each tube but also the equivalent filter of the tube wall for a range of potentials.

Ernst A. Pohle, M.D., Ph.D.

A New Roentgen Therapy Tube for High Intensities with an External Anticathode Constructed by the "Compagnie Generale de Radiologie." J. Belot. Bull. et Mém. Soc. de Radiol. Méd. de France, **26,** 153–158, March, 1938.

A new tube for therapy at 200 kv. has been designed, of which the chief feature of interest is the design of the anode end. The cathode is conventionally placed in a glass tube which is sealed by a special collar at the anode end to a funnel-shaped tube of copper, the open, narrow end of which projects into the glass tube in line with the cathode ray. At the wide end of the copper tube, cut obliquely, is the tungsten anode, set into a heavy sheet of copper which has a spiral groove on the back for better oil circulation. The copper tube has a thinned-out area for a window. It is surrounded by a lead cylinder, for protection against radiation, which has an opening to correspond to the window. A heavy porcelain insulator holds the tube, with its attached oil tube and electrical connections, inside a metal shield of conventional design wherein circulates the oil for cooling. The high tension leads are conventional.

This design allows better cooling of the anode, lessens internal electrical strain, permits the use of heavy glass in the tube wall, and gives better protection from radiation.

At 200 kv. C.P., 18 ma., filtration total 1 mm. Cu + 2 mm. Al, 40 cm. F.S.D., 100 r per minute are obtained.

S. R. Beatty, M.D.

Stereoscopic Roentgenograms. E. Hagenbach. Schweiz. med. Wchnschr., **68,** 598, 599, May 21, 1938.

A brief review of the uses of stereoscopy. The article is apparently intended to educate non-radiological practitioners to want this type of examination.

L. G. Jacobs, M.D.

The Amount of Off-focus Radiation in Beams from Various Types of Roentgen Tubes. R. Thoraeus. Acta Radiol., **18,** 753–760, October, 1937.

The off-focus radiation observed in seven different types of x-ray tubes varied from 9 per cent to 25 per cent. It is practically independent of tube voltage and filtration, very heavy filters excepted. The voltages employed in the experiments ranged from 60 kv. to 165 kv.

Ernst A. Schmidt, M.D.

Rotating Anode X-ray Tube. Robert A. Powers. Calif. and West. Med., **48,** 339–341, May, 1938.

An excellent description of a rotating anode tube is presented, bringing out clearly the advantages and disadvantages. The author concludes that the tube is a valuable addition to diagnostic x-ray equipment.

James J. Clark, M.D.

Modern Darkroom Illumination for Roentgen Laboratories. Fritz Luft and Martin Blitz. Röntgenpraxis, **10,** 321–326, May, 1938.

The color of the darkroom light must be chosen in such a way that it appears as bright as possible to the eye and that it acts as little as possible on the photographic film. In order to determine this relationship quantitatively the spectral sensitivity of the eye for light and dark adaptation, and the spectral sensitivity

of the roentgen film were worked out. The best value and the best proportion for both were found. This value determines the color of the darkroom light.

The sensitivity of the eye for the different portions of the spectrum is dependent on the adaptation of the eye to light or dark. For an eye adapted to light the red-brown Agfa filter 104 is recommended; for an eye adapted to the dark the yellow-green Agfa filter 117.

The use of monochromatic light does not lead to an appreciable increase in efficiency.

HANS W. HEFKE, M.D.

The Measurement of Impedance in Edema. A. Denier. Bull. et. mém. Soc. de Radiol. Méd. de France, **8**, 110–112, February, 1938.

The author describes briefly his modification of an apparatus for measurement of impedance. The capacity and the resistance must both be considered, as the measurement of resistance only is subject to many errors.

He distinguishes three groups as determined by his technic of measuring the local impedance:

In hypercholestemia and venous stasis both capacity and resistance are increased.

In sodium retention and phospholipoid precipitation the capacity is increased and the resistance diminished.

In the third group the capacity and resistance are both diminished. In this group fall the obese, those with vasomotor disturbance, thyroid insufficiency, muscular hypotomy, and alkalosis. In cancer these decreases are particularly notable.

S. R. BEATTY, M.D.

BACKACHE

Low Back Pain with Sciatic Radiation: Recent Advances in Treatment. Maxwell Harbin. Jour. Med. Assn. Ga., **27**, 147–152, April, 1938.

Three causes of low back pain with sciatic radiation are discussed, namely, fibrositis, herniated intervertebral disk, and hypertrophied ligamentum flavum.

Fibrositis is diagnosed by exclusion and a careful history and physical examination. The roentgen examination is negative. There may be atrophy of the calf muscles and an absent Achilles' tendon reflex. Treatment is by the Ober operation of division of the ilio-tibial band or stripping of the fascia from the sacro-iliac joint.

Herniated intervertebral disks are found to be a more frequent cause of pain than has been suspected. Ninety per cent of the ruptured disks are found in the low lumbar region. Patients are usually healthy, vigorous men who complain of back pain of long standing following an injury or strain. Pain radiates down the thigh and calf. Various neurologic symptoms may be found, the most common being a decreased ankle reflex. Sensory impairment is rare. Pain is only temporarily relieved by the usual measures. If the spinal fluid total protein is elevated above 40 mg. per cent it is believed necessary to put iodized oil in the spinal canal and make serial films in various projections. The defect in the oil shadow occurs at the intervertebral space and may be partial or incomplete. The herniated fibrocartilage is removed by laminectomy.

Hypertrophy of the ligamentum flavum produces much the same clinical symptoms and the same type of filling defect on the x-ray films. The ligament is composed of yellow, elastic tissue and repairs trauma with fibrous connective tissue. There may be an overgrowth of repair tissue, with resultant pressure on the emergent nerve root, the dura or cauda equina. Treatment is by surgical removal after laminectomy.

J. E. WHITELEATHER, M.D.

Differential Diagnosis of Pain Low in the Back: Allocation of the Source of Pain by the Procaine Hydrochloride Method. Arthur Steindler in collaboration with J. V. Luck. Jour. Am. Med. Assn., **110**, 106–112, Jan. 8, 1938.

The authors approach the problem of allocation of pain by following the routes of sensory supply to the tissues of the lumbosacral region. The posterior division of the lumbosacral portion of the spinal nerve supplies the long muscles of the back (sacrospinalis), all the posterior ligamentous structures, the aponeuroses and periosteal attachments, a portion of the gluteal fascia, the lumbodorsal sheath, the supraspinous and interspinous ligaments, the superficial and the deeper iliosacral ligaments, the sacro-ischial ligaments, and in part the iliolumbar ligament, the intervertebral articulations, and the sacro-iliac articulations. Irritations are apt to produce either sharply localized superficial pressure points at ligamentous and aponeurotic attachments or more diffuse areas of tenderness in muscles and sheaths. These localized peripheral lesions are capable of producing radiation not only in the posterior but in the anterior division along many different pathways. Furthermore, they produce postural anomalies the same as those produced by irritation of the nerves of the anterior division.

The pathways of the anterior division do not involve the immediate problem. Probably more cases are of purely reflex origin and not due to direct compression in the intervertebral canal than is generally accepted.

One would expect a large portion of cases of low back pain to belong to the posterior syndrome group. This division, comprising the long muscles of the back, their aponeuroses and periosteal insertions, and their muscle sheaths and superficial ligaments, forms one physiologic unit. Tension is transmitted to the whole system either by contracture of the muscles of the back (forward flexion test) or by stretching of the hamstrings (Lasègue's sign) and it is significant that this sign is negative in cases of true neuritis and in tumor of the cord, and positive in cases of fibrositis and myofascitis of the muscles of the back. The pain involves the nearest structure put under strain in cases of trauma, and the first one to give under continued stress in the postural and degenerative group.

There is a syndrome involving the deep posterior division, that is, the deeper ligamentous structures of the sacro-iliac junction, the iliolumbar ligament, and also the transverse sacral process in cases of sacraliza-

tion. These structures are supplied totally or in part by the posterior division of the lumbosacral region. Signs are found indispensable both for the superficial and for the deeper local lesion in the territory of the posterior division.

Recognizing that local tenderness, radiation, and faulty posture must apply for the posterior as well as for the anterior division syndrome, the authors attempted to single out those cases in which a definite localized source of pain was found by palpation, and in which the leg signs consistently referred to this localized tender point. The structures involved were all supplied by the posterior division of the spinal nerves. They next tried to establish the relation of this local point to radiation.

The test was made by injecting into the area of local tenderness from 5 to 10 c.c. of a 1 per cent solution of procaine hydrochloride. The involved tissue was identified by a definite sensation of pain when the point of a deeply inserted needle came in contact with it. Contact with the needle aggravated the local pain, elicited or aggravated radiation. The procaine hydrochloride infiltration suppressed local tenderness and radiation and the positive leg signs disappeared. When all these requirements were met, the patient was considered as reacting positively to the test, and the radiation was a reflex phenomenon elicited by the local lesion.

Conservative treatment by immobilization and physical therapy was most successful in patients reacting positively.

CHARLES G. SUTHERLAND, M.D.

BONE DISEASES (DIAGNOSIS)

Changes Simulating Legg-Perthes' Disease (Osteochondritis Deformans Juvenilis) Due to Juvenile Myxedema: Report of a Case. Fuller Albright. Jour. Bone and Joint Surg., **20,** 764–769, July, 1938.

This is a case report of an instance of coxa plana developing in a child with hypothyroidism, with eventual reformation of the femoral head after adequate thyroid therapy. The condition is to be differentiated from true Legg-Perthes' disease.

J. B. MCANENY, M.D.

Familial Disseminated Osteosclerosis. K. F. B. Busch. Acta Radiol., **18,** 693–714, October, 1937.

The author studied 15 cases of familial disseminated osteosclerosis, 14 of which occurred in one family, distributed over three generations. The bone changes can be visualized roentgenologically from the second to the third year of age. Six of the patients showed skin alterations which are commonly described in the dermatologic literature as "disseminated lenticular dermatofibrosis." The author believes that disseminated osteosclerosis is unrelated to the so-called "compact tissue islands," as is claimed by some investigators. He also declines the theories assuming either an infectious or an endocrine etiology for the condition which he simply considers "a benign, familial, constitutional, anomaly," localized in the skeleton and occasionally in the skin.

ERNST A. SCHMIDT, M.D.

Ossification of the Internal Paracondyle of the Femur (Pellegrini's Disease). Carlo Guarini. Archivio di Radiologia, **16,** 431–446, September–December, 1937.

Guarini here reports 13 cases found in 3,500 patients examined roentgenologically after trauma in two years. The ossifications were of varying size, shape, and consistence but the author never demonstrated osseous trabeculation in them. In all cases the outline of the condyle was sharp. In this series of cases, involvement of the right knee occurred ten times. Guarini has found Marconi-therapy of value in treatment. The author cites an extensive list of references.

E. T. LEDDY, M.D.

Larsen-Johansson's Disease of the Patella and Schlatter's Disease. E. Glanzmann. Schweiz. med. Wchnschr., **68,** 494–497, April 30, 1938.

The author reports the case of a girl, referred for a minor trauma, who was found to have a left-sided bipartite patella, the upper loculus of which had undergone an aseptic necrosis of the Sinding Larsen type. Her cousin had a bilateral Schlatter's disease, and her uncle, a bilateral exostosis of the adductor tubercle. The factors in the development are discussed at some length. The author believes that both these conditions, Perthes' disease, both Köhler's diseases, and spinal osteochondritis are related. The existence of anomalous ossification centers is predisposing to an aseptic necrosis. The condition is often familial, showing an ill-defined dominance, and alternation of exostoses and aseptic necroses may be observed.

L. G. JACOBS, M.D.

CALCINOSIS

Calcinosis Cutis. M. E. Pusitz, A. K. Owen, and G. A. Finney. Jour. Am. Med. Assn., **110,** 360–363, Jan. 29, 1938.

Calcinosis cutis is defined as a pathologic state in which calcium deposits are laid down in the skin and subcutaneous tissues. As such, it must be differentiated from myositis ossificans, calcification of hematomas, calcified tumors, phleboliths, atheromas, calcified tubercles, or calcified lesions due to parasites such as *Trichinella*, the calcification in cysts, or even production of osteomas in the skin. With these pathologic states left out of consideration, one has left two main syndromes, one which is not connected (supposedly) with parathyroid activity, which has been termed idiopathic calcinosis cutis, and the other, which may be accompanied by definite evidence of hyperparathyroidism even if no adenoma may be clinically or surgically discovered. The authors prefer to classify the latter

among the cases of idiopathic calcinosis rather than as examples of hyperparathyroidism. Calcification associated with scleroderma, dermatomyositis, Raynaud's disease, or local arteriosclerosis appears to be due to local conditions.

The causation is unknown. Since the majority of patients are females, an attempt has been made to involve endocrine disturbance. The widespread nature of the condition at once rules out trauma as a definite factor. Calcification following a degenerative process affecting the fat lobules was suggested, but it has been shown that such necrosis does not occur in the fat cells.

In calcareous infiltration there is a deposition either in the cells or in the intercellular substance of larger and smaller granules, composed chiefly of calcium phosphate and carbonate. Normal skin does contain a small amount of calcium, but this is not sufficient to be noted under the microscope. When the collection of these granules becomes abundant enough there is a hardness, a brittleness, and a whitish appearance of the affected tissue. Under the microscope they appear dark by transmitted and white and glistening by reflected light. These pathologic calcifications are retained, not in the diffuse state in which they exist in bone, but in particles or clumps. The calcium compounds, however, are the same in both normal and pathologic states. Initial histopathologic change in cutaneous calcinosis consists of a deposition of fine granules of calcium salts around apparently normal fat cells in the subcutaneous tissue. This is not accompanied by necrosis or acute inflammatory change.

The routine examination of the blood, the urine, and the stool does not yield pathologic data.

CHARLES G. SUTHERLAND, M.D.

CANCER (DIAGNOSIS)

The Direct Demonstration of Bronchial Stenosis in Bronchial Carcinoma. Heinrich Eschbach. Röntgenpraxis, **10,** 294–303, May, 1938.

Three methods are of great importance for the diagnosis of bronchial carcinoma; roentgen examination, bronchography, and bronchoscopy. The direct demonstration of the bronchostenosis without the use of contrast material has been described only by Lenck. The demonstration of these cancers is usually possible by a Bucky film, because they are commonly situated close to the bifurcation and within the hilar shadows, which makes a good contrast of the air in the trachea and the main bronchi possible. The examination must be done in deep inspiration and in horizontal position by means of the Bucky, usually best in postero-anterior direction of the rays.

By means of films and diagrams the author proves his contention that a direct visualization of the stenosis in the bronchus is possible in many cases, when the technic is correct. One cannot succeed in all cases; kyphosis, adipositas, and widening of the aorta for instance are factors which might make such a demonstration impossible. Parenchymatous tumors of the lungs or tumors originating in a small bronchus will of course not allow the x-ray diagnosis of a stenosing lesion in a bronchus.

The author believes that the roentgen diagnosis of cancer of the bronchus is made much more reliable when this method is added. If the findings are positive he believes bronchography and bronchoscopy may be omitted in certain cases when such rather strenuous types of examination are too severe for the patient.

HANS W. HEFKE, M.D.

The Geneva Classification of Carcinomas of the Collum Uteri. J. Ducuing. Acta Radiol., **19,** 13-22, March, 1938.

Pointing out the difficulties inherent to any attempts at medical classification, the author discusses the classification of cancers of the uterine collum as adopted in 1929 by the "Radiological Sub-commission of Cancer" of the League of Nations. In this classification the author criticizes: (1) certain negative definitions, *e.g.*, the attribution to Stage III of all cases not to be referred to Stages II or IV; (2) the conception of mobility, difficult to define and uncertain with regard to cause (infection or tumor); (3) certain defects in the subdivision of the different stages, *e.g.*, cancers with adenopathies and discontinuous propagation being placed in Stage III instead of Stage IV (according to Ducuing); (4) the lack of precision in the definition of certain cases in certain stages, the author considering it necessary to specify further, *e.g.*, to say Stage III (vagina) or Stage III (parametrium), and similar.

For cancers which escape definite classification under this system, rubrication in a column of "remarks" or "special cases" is suggested.

ERNST A. SCHMIDT, M.D.

Pseudo-esophageal Type of Cancer of the Bronchus. Rebattu, Gravier, and Sprecher. Jour. de méd. de Lyon, **18,** 459–461, Aug. 20, 1937.

A case presenting first recurrent paralysis and latter symptoms and roentgenologic evidences of esophageal carcinoma was proven by bronchoscopy and biopsy to have bronchogenic cancer. In all mediastinal syndromes, endoscopy should be performed as the roentgenologic findings are not always conclusive.

S. R. BEATTY, M.D.

Appearance of a Lesion in October, 1937, in a Patient Observed since October, 1930, because of a Gastritis Syndrome: Radiologic Signs and Surgical Verification. Maurice Delort. Arch. d. mal. de l'app. digestif, **28,** 159–164, February, 1938.

A patient who had been observed clinically for seven years because of gastritis with hypo-acidity and achlorhydria, developed suddenly an attack of vertigo and abdominal pain followed by loss of appetite. Roentgenologic examination demonstrated a small lesion of the greater curvature which microscopically was a scirrhous carcinoma.

S. R. BEATTY, M.D.

CANCER (THERAPY)

Six-year End-results in the Treatment of Uterine Carcinoma in the St. George General Hospital in Hamburg. A. Hamann and A. Göbel. Strahlentherapie, 1938, **62,** 251.

Four hundred seventy-six cases of gynecological carcinoma treated from June, 1929, to December, 1931, at Holthusen's institute in Hamburg are statistically analyzed by the authors. Of these cases, 379 had carcinoma of the cervix and 34 of the fundus. The majority of the cervical cancers (63.2 per cent) were treated radiologically. Twenty per cent were free from symptoms after five years and 19 per cent after six years. In the group with carcinoma of the fundus, approximately equal numbers were treated by radiation only and by a combination of surgery and irradiation. The five- and six-year cures were 21.6 and 20.1 per cent, respectively. An analysis of the treatment methods used shows that the protracted fractional dose method is not superior to simple fractionation as far as the end-result is concerned. However, the patients tolerated the protracted fractional doses better, there were fewer late skin reactions, and fewer intestinal disturbances.

ERNST A. POHLE, M.D., Ph.D.

Palliation of Cancer in Gynecology. Frank R. Smith. Am. Jour. Roentgenol. and Rad. Ther., **39,** 866–870, June, 1938.

The author states that the majority of the gynecological carcinoma cases presenting themselves to cancer institutions are patients with advanced disease. Palliative care is given to relieve such symptoms as pain, hemorrhage, and obnoxious discharge. The palliative treatment includes administration of drugs for relief of pain, cauterization for control of hemorrhage, and removal of bulky tumors and irradiation for control of infection. Vaginal fistulæ are in most cases a manifestation of advanced disease and when they occur after radiation therapy they should not be repaired until the patient has remained free from disease for five years. Several illustrative case reports are given.

IRVING I. COWAN, M.D.

CONTRAST MEDIA

The Basis, Limits, and Toleration of Endobronchial Iodized Oil. Günther Anton. München. med. Wchnschr., **85,** 919–923, June 17, 1938.

The tolerance of a lung for an endobronchially injected medium is dependent on the age of the patient and the pulmonary or general disease concerned. Circular lesions of the ciliated epithelium of the bronchi tie up the removal of the oil by way of the trachea. The roentgenologically demonstrated damage to the lung, as, for example, a lung carcinoma leads to a delayed elimination of the endobronchially administered oil, apparently through injury to the alveolar epithelium. Iodols and not iodized oils can cause allergic reactions endobronchially. Fractional filling in bronchiectasis in selected cases will have no after-effects if the tolerance of the lung at subsequent fillings is not overstepped.

L. G. JACOBS, M.D.

Lipiodol Emboli in the Brain and Lungs after Hysterosalpingography. G. Hemmeler. Schweiz. med. Wchnschr., **68,** 717–719, June 18, 1938.

The author reports a case in which, following a hysterosalpingography for sterility, severe symptoms, both physical and mental, ensued. Roentgenograms showed flow of the lipiodol into the uterine plexus, and a film of the lungs two days later showed evidence of fat embolus. The patient recovered rapidly without sequelæ. The author comments on the rarity of reports of this accident in the literature.

L. G. JACOBS, M.D.

DIVERTICULITIS

Diverticulitis. Edwin A. Nixon. Northwest Med., **37,** 97–100, April, 1938.

The essayist states that the commonest lesions found in the colon are diverticula and their sequelæ, and that the surgical treatment of these lesions consists primarily in treating their complications.

A description of the origin of the word "diverticulum" and its etiology follows. Quoting from Willard and Bockus, the writer gives the following clinical findings: 87 per cent of the patients had pain in the left lower abdomen; 39 per cent, bleeding from the bowels; 37 per cent had rise of temperature; 35 per cent had constipation, and 15 per cent had diarrhea. Bladder symptoms were found in 50 per cent of the patients suffering from diverticulitis.

It has been only recently that the profession has become diverticulitis-conscious. Twenty years ago it was considered a pathologic curiosity.

Sigmoidoscopic examination seldom reveals the lesion. Roentgen examination offers a more satisfactory method to detect and determine the number of diverticula. The method given is the one used by the radiologists of the Naval Hospital at Bremerton. The patient is given one ounce of mineral oil, and one drachm of fluid extract of cascara the night before examination. At 8:00 A.M. soap suds enema and one hour later plain water is used for colonic flushing until the water returns clear. An enema consisting of one pound of barium, four ounces of powdered acacia, and three quarts of water is given under fluoroscopic control, using forceful manipulation to thoroughly spread the mixture. Two films are made; one before evacuation of the enema, and the other, a contrast enema, after air has been injected under fluoroscopic control.

The author arrived at the following conclusions:

1. Diverticula and their sequelæ are the commonest lesions to be found in the colon.

2. Age and constipation cause these lesions to form through weakened musculature in the aneimesenteric border of the colon, and into the epiploic appendages.

3. Roentgenologic examination by the combined barium enema and air injection offers greater opportunities for studying the numbers and locations of the diverticula.

A. MAYORAL, M.D.

FOREIGN BODIES

The Exact Localization of Marginal Intra-ocular Foreign Bodies. H. Goldmann. Schweiz. med. Wchnschr., **68,** 497, 498, April 30, 1938.

After discussing briefly the methods of localizing foreign bodies in the eye, the author advocates a "bone-free" or intra-orbital film technic, in which a small metal ring is placed on the globe in a plane perpendicular to the beam, and adjusted till the foreign body lies in the center of the ring shadow. This gives a very precise localization for surgical intervention.

L. G. JACOBS, M.D.

New Procedure for Localization of Foreign Bodies in the Eye. P. Cottenot. Bull. et mém. Soc. de Radiol. Méd. de France, **8,** 89, 90, February, 1938.

The author describes his technic of foreign body localization in the eye, using his modification of the seriescope and two films taken with a tube shift toward the feet. A special contact lens with lead markers is necessary.

S. R. BEATTY, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

What Kind of Roentgen Examination of the Digestive Organs can the General Practitioner Commend? W. Kaufmann. München. med. Wchnschr., **85,** 625–629, April 29, 1938.

A very general review of the method and technic as well as the diagnostic points of gastro-intestinal roentgenography.

L. G. JACOBS, M.D.

Hepato-diaphragmatic Interposition of Loops of Small Intestine and its Relationship to Other Affections (Gastrectasia, Pneumatosis Cystica, etc.). Aldo Piergrossi. Archivio di Radiologia, **16,** 410–429, September–December, 1937.

Piergrossi, of Naples, describes the pathogenesis of this lesion, first described by Béclère in 1899, and illustrates the roentgenologic findings associated with it. In the majority of instances the lesion is associated with some other gastro-intestinal abnormality such as dilatation and atony of the stomach, gastric or duodenal ulcer, adhesions, pneumatosis cystica, etc. The author feels that traction between the stomach and liver, together with other co-existing conditions, causes the interposition. The article is accompanied by a good bibliography.

E. T. LEDDY, M.D.

HEART AND VASCULAR SYSTEM

Intra-arterial and Intra-cardiac (Left Ventricle) Injections. Carlos Burgos. Annaes Paulistas de Medicina e Cirurgia, **35,** 217–223, March, 1938.

The author admits that intra-arterial injections are not new, and reports excellent results in 16 cases in which they were used in cases of infections in the extremities. He feels that many limbs were saved by the procedure. The medical agent used is named in the text.

He also reports a case of tetanus in which the serum was injected into the left ventricle, with the patient under chloroform anesthesia. Not even alteration of the pulse was caused. The patient recovered.

A. MAYORAL, M.D.

Roentgen Kymographic Study of the Heart. G. M Tice. Jour. Kansas Med. Soc., **39,** 198–201, May, 1938.

The literature on this subject is reviewed briefly, together with details on the construction of apparatus. The appearance of the normal kymogram has not been definitely established and when this is done the value of the method will become definitely greater. The author has not found the kymogram particularly valuable in the differential diagnosis of aneurysm and mediastinal tumor. It does record the movements of the various segments of the cardiac borders but the findings may be difficult of interpretation. Myocardial damage often shows characteristic changes in the wave form. Irregularities in rhythm can be detected. The kymographic findings should be correlated with the other clinical and laboratory data to obtain the most value from the examination.

LESTER W. PAUL, M.D.

HERNIA

Diaphragmatic Hernia. Joseph C. Root and Clark P. Prickett. Cleveland Clinic Quarterly, **5,** 203–216, July, 1938.

The authors found 31 diaphragmatic hernias in 2,213 routine gastro-intestinal series. The different types are classified as: (1) thoracic stomach; (2) diaphragmatic hernia with short esophagus; (3) hiatus hernia—esophagus of normal length; (4) congenital hernia; (5) traumatic hernia; (6) congenital absence of diaphragm.

Each type of hernia is defined and discussed as to origin and appearance on x-ray examination. Reproductions of illustrative films are presented. Symptomatology, physical findings, diagnosis, and treatment are sketched.

J. B. MCANENY, M.D.

INFLAMMATORY DISEASES

Optimum Effective Doses in Roentgen Therapy of Inflammatory Affections. Gaston Daniel. Bull. et mém. Soc. de Radiol. Méd. de France, **26,** 55–65, January, 1938.

The author discusses the technic of roentgen therapy in inflammatory conditions, and, in particular, his use of very small doses. In acute conditions he employs 25–28 kv. effective, 4 ma., 35–40 cm. F.S.D., no filter or 1 cm. of leather for superficial infections and no filter up to 4 mm. Al in more deep-seated processes. Superficial infections receive from 1 r to 3 r; deep infections, as of the pelvis, 0.01 r to 1 r (effective in the tissues) at each sitting, repeated as necessary at from three- to five-day intervals. In chronic infections five or six doses of about 10 r on the skin are given in five minutes with 25 kv. effective, 4 ma., 35 cm. F.S.D., employing filtrations of 0.05 mm. Al.

To render a chronic lesion acute, vaccines are frequently injected after preliminary irradiation of the involved area, the area of vaccination is treated at the stage of maximum reaction and from four to six hours later the lesion is again treated. Another dose may be given after 12 hours but is seldom necessary.

The effect of such doses is limited to the infectious process. The sympathetic nervous system requires much larger doses before it is affected.

In 67 cases of acute and subacute infections of various types, the author reports 66 cures, with benefit in the remaining case, one of anthrax in which larger doses and incision were necessary. Parallel results were observed in chronic infections.

S. R. Beatty, M.D.

Indications, Technic, and Results of Radiotherapy of Inflammatory Conditions of the Tonsils and Nasopharynx. André Meyer. Bull. et mém. Soc. de Radiol. Méd. de France, **26,** 48–52, January, 1938.

The author reviews a number of articles dealing with the use of roentgen therapy in inflammatory conditions of the nose and throat, and reviews his own experiences in a small series of cases (27).

Roentgen therapy offers an effective, safe, and painless means of therapy in the following conditions:

1. Acute inflammation—acute angina (dose 50–100 r).
2. Chronic inflammations, chronic tonsillitis, recurrent angina, chronic pharyngitis with metastatic focal infections (dose up to 2,500 r).
3. Diphtheria carriers, chronic streptococcic throat infections (500–1,000 r).
4. Certain forms of tonsillar hypertrophy and hypertrophy of the nasopharyngeal lymphoid tissues (dose 1,000 r–4,000 r).
   (*A*) With surgical contra-indications, as hemophilia, cardiac, pulmonary, renal disease, etc.
   (*B*) Recurrences after surgery.
   (*C*) Forms difficult for surgical treatment as lingual tonsils, diffuse hypertrophy, etc. Simple tonsillar hypertrophy should be treated surgically.

The author's technic: 200 kv., 30 cm., F.S.D., 1 mm. Cu to 1.5 mm. Cu plus 2 mm. Al filtration with fields 4.8 cm. diameter over each tonsillar area. Two or three treatments a week, of from 200 r to 400 r are given, to each side alternately. The more acute the condition the smaller the dose.

The results of roentgen therapy are such that in the above conditions it should be considered the method of choice.

S. R. Beatty, M.D.

Radiation Therapy in Benign and Malignant Diseases of the Ear, Nose, and Throat. H. W. Hefke. Wis. Med. Jour., **37,** 551–554, July, 1938.

There are many diseases involving the ears, nose, and throat which are amenable to or, are palliated by, radiation therapy. Among the conditions listed by the author are the following: inflammatory diseases of the nose and throat, acute and subacute cervical adenitis, septic and post-operative parotitis, phlegmons about the face and mouth, furuncles and carbuncles, keloids, hemangiomas. In all of the malignant diseases in this area radiation therapy has some place and in many of them it is the method of choice. No detailed technical methods are given but some of the more recent advances, especially the Coutard technic, are discussed.

Lester W. Paul, M.D.

THE KIDNEYS

Studies on the Pathology of the Renal Papilla. Alexander Randall, John E. Eiman, and Paul R. Leberman. Jour. Am. Med. Assn., **109,** 1698–1702, Nov. 20, 1937.

A primary renal calculus must be stationary and attached while beginning and acquiring growth; small renal calculi almost always show such a stoma, or facet, of mural attachment. X-ray studies in proper cases repeatedly showed that primary renal calculi have their origin in the minor calices. In a series of postmortem investigations a new pathologic lesion of the renal papilla was observed, consisting of a deposit of calcium in the basement membrane of the collecting tubules and in the intertubular connective tissue. Such deposits, or calcium plaques, while intrapapillary were innocent of further harm, but when they occurred near the surface of the papillary wall they were prone to lose their surface covering of epithelium and when so denuded, could and did act as the nidus on which the salts in the caliceal urine were deposited, and a stone was formed. These calcium plaques proved on chemical analysis to consist of calcium carbonate, calcium phosphate, and perhaps calcium nucleinate. By chemical analysis pure calcium phosphate calculi and pure calcium oxalata calculi were proved thus to grow in man.

In experimental reproduction of these lesions the introduction of bacteria *per se* was not essential to the

problem. As the lesion gave every evidence of being a calcium deposition in response to some form of damage to the collecting tubules, there was the possibility that the concentration of some toxic material at this point could be the primary cause. Experiments seemed definitely to prove that the kidney can and does concentrate this toxic material from two and a half to 60 times the blood stream content. The elimination of a streptococcus toxin through the kidney can cause definite localized damage, which is most marked in the walls of the collecting tubules. Efforts to reproduce this calcium plaque formation in lower animals by vitamin-deficient diets failed. After the administration of parathyroid extract to dogs for six months a calcium plaque was observed identical to that seen in man in one renal papilla.

The occurrence of renal calculus in man is essentially only a symptom of some underlying pathologic condition of a renal papilla. Its entire development is a slow chronic process. Acute results obtained in experiments on animals are not comparable to the clinical picture.

CHARLES G. SUTHERLAND, M.D.

Roentgenological Examination of the Kidney, with Special Reference to Backflow and Injuries Associated with Retrograde Pyelography. William E. Stevens. Jour. Urol., **39**, 598–610, May, 1938.

Excretory urography alone is sufficient for an accurate or complete diagnosis in a limited number of cases. During retrograde pyelography the renal pelvis may be perforated by a ureteral catheter or bougie or ruptured by excessive pressure during injection of the pyelographic medium. Chemical necrosis may also perforate the pelvis. The author believes it is impossible to perforate a normal kidney pelvis in an adult with an ordinary catheter or bougie.

Extreme gentleness should be employed in catheterization and injection of the renal pelvis in infants and young children.

Injury to the kidney and backflow are not uncommon during retrograde pyelography; the principal danger of such happenings lies in the dissemination of infectious material. Rupture extending through the capsule of the kidney is the most dangerous complication associated with retrograde pyelography.

The author presents 23 cases demonstrating perforation of the renal pelvis, lymphatic backflow, pyelovenous backflow, and tubular backflow.

JOHN G. MENVILLE, M.D.

THE LUNGS

The Evolution of the Parenchymal Lung Lesions in Rheumatic Fever and Their Relationship to Mitral Stenosis and Passive Congestion. Benjamin Gouley. Am. Jour. Med. Sci., **195**, 1–10, July, 1938.

The pulmonary changes in rheumatic fever cannot be accounted for wholly on the basis of congestive failure or mitral stenosis, since both factors may be absent or developed to a varying degree. They are in part due to the parenchymal disease which occurs during the generalized infection.

The rheumatic pneumonopathy can be identified as an interstitial hematogenous inflammation, characterized, in the acute stage, by monocyte invasion and fibrinoid necrosis, which are later replaced by multinucleated basophilic cells, the "Aschoff" cells. Still later there is an invasion by plasma cells, lymphocytes, and fibroblasts. In some cases Aschoff nodules may be found. An important feature is the destruction of the elastica.

Marked changes in the consistency of the lung tissue and occasional basal atelectasis, which is probably due to the loss of elastica, feature the subacute stage.

In the chronic stage, the lung is "rubberoid" in consistency, and microscopically shows a patchy interstitial pneumonitis with marked hyperplasia of the elastica. This latter, called "elastosis" by the author, is not pathognomonic of a rheumatic infection. The arteritis and arteriosclerosis are of secondary importance in the development and evolution of the rheumatic lung disease.

BENJAMIN COPLEMAN, M.D.

Thoracoplasty with Extrafascial Apicolysis. C. Semb. British Med. Jour., 650–656, Oct. 2, 1937.

The author's method satisfies the three requirements for thoracoplasty: (1) it causes a complete collapse of the cavity; (2) it causes a selective collapse of the cavity; (3) the operative risk is small. This method is characterized by three chief points: (1) apicolysis in the extrafascial plane by cutting the so-called suspension bands of the lungs sharply or bluntly; (2) a radical rib resection according to the extent of the apicolysis, or more; (3) preparation of an extrafascial space by cutting periosteum of ribs in such a manner that they are not loosened from the surface of the lung. The result of the third stage is such that the periosteum-bearing tissue collapses with that portion of the lung containing the cavity, and later, when osseous tissue is formed by the periosteum, it forms in such a fashion as to contact and support the lung in its new position. The operation is done in several stages. The mortality is less than 3 per cent. The collapse of the cavity has been selective in 14 out of 16 patients who had been operated on by other methods without success.

W. H. GILLENTINE, M.D.

Solitary Congenital Pulmonary Cyst: Report of One Case. Paul C. Gunby. Western Jour. Surg., Obst., and Gynec., **46**, 321–324, June, 1938.

The patient was admitted to the Out-patient Department of the Children's Hospital in Seattle, in June, 1935, with a history of a draining empyema sinus of two years' standing; a complication of a typical attack of left bronchial pneumonia. At the time of study the

patient had had numerous drainages of the chest with removal of portions of the ninth, tenth, and eleventh ribs, posteriorly. Drainage from the cavity was of a mucoid character. The clinical condition of the patient was good. A diagnosis of solitary congenital cyst was suspected and the entire lining of this cavity was removed and the wound closed with drainage. The cyst replaced the entire lower lobe and measured nine centimeters in diameter with walls varying between one and 12 millimeters.

Attention is called to an article describing similar cases by Dr. Eloesser, published in 1931. The pathology of the condition is discussed. The cysts, when solitary, are symptomless unless infection occurs. The walls are characteristically trabeculated and clean, and a glary mucoid discharge is found.

W. H. GILLENTINE, M.D.

MAXILLARY FRACTURES

Kirschner Traction in the Treatment of Maxillary Fractures. Glenn Major. Jour. Am. Med. Assn., **110,** 1252–1254, April 16, 1938.

A high percentage of fractures of the upper jaw are complicated by fracture of the skull through the anterior cranial fossa. Most of these fractures are compound, projecting through the nose, and nasal drainage of cerebrospinal fluid is usually present. Obviously, the first consideration is the possibility of injury to the brain, due either to laceration or to hemorrhage, and the second consideration is the potentiality of intracranial infection in the nature of meningitis, sinus thrombosis, or abscess of the brain. The patient should be treated conservatively for a week at least, the treatment being that ordinarily employed for fracture of the skull. In addition, the maxilla should be immobilized as completely as is possible with a head-chin bandage, a procedure which is grossly inadequate at best. The nose should be sprayed at frequent intervals; the author uses tincture of merthiolate. If the fracture is accompanied by injury to the facial attachments of the ligament or by laceration of the ligament itself, diplopia often results. It is then imperative that the fragments be reduced accurately, so that the two eyeballs are brought to the same normal horizontal level.

Rarely does a fracture of the maxilla occur in which the fracture line does not involve one of the maxillary frontal or ethmoid sinuses. Marked sinus infection after such an injury is the exception rather than the rule. Tardiness of union of the bone is a feature worthy of note. All splints may be removed at the end of from three to five weeks, but as a general rule several more weeks, or sometimes months, must elapse before complete firm union has resulted. Union is usually prompt in fractures of the maxilla. Osteomyelitis is uncommon in the maxilla and occurs in the mandible in from 5 to 10 per cent of cases.

The author describes a method for the gradual reduction of horizontal fractures of the maxilla, based on the principles of skeletal traction and involving a Kirschner wire. This effects gradual and complete reduction of these fractures, and tremendous force may be exerted, if desired, with practically no discomfort to the patient. The apparatus can easily be applied with the patient under local anesthesia, and there is little possibility of additional intracranial injury or infection, because of the gradual reduction.

CHARLES G. SUTHERLAND, M.D.

PROTECTION

Secondary Radiation from Protective Walls in Hard Roentgen Radiation. Ragnar Bernstedt. Acta Radiol., **19,** 85–101, March, 1938.

Of the commonly used building and protective materials, lead showed the smallest amount of secondary radiation. Only barite tiles offered comparable protection. It is interesting to note that, for protection against voltages used in diagnostic rooms, the secondary radiation was smallest when the lead was placed on the far side of the wall from the tube, while, according to the author, placing of the lead on the tube side of the room was slightly more advantageous when therapeutic voltages were used.

ERNST A. SCHMIDT, M.D.

SARCOMA

Osteolytic Osteogenic Sarcoma, with a Report of Eight Five-year Survivals. I. S. McReynolds. Surg., Gynec. and Obst., **67,** 163–168, August, 1938.

Ninety-nine of a series of 131 cases of osteolytic sarcoma were followed for five years, at which time eight were surviving. These lived from six to ten years longer. Ninety-two per cent of all cases died within the five-year period, the average duration of life being 10.3 months after the primary treatment. Primary amputation well above the location of the tumor, or radical resection where possible, are considered the treatments of choice. Roentgen-ray therapy is considered palliative for pulmonary metastases. The general subject is concisely reviewed and the eight cases are presented in detail.

W. R. BROOKSHER, M.D.

SKIN DISEASES

Clinical Management of Skin Cancer. Eric Liljencrantz and George V. Kulchar. Calif. and West. Med., **49,** 30–36, July, 1938.

The authors have presented a very excellent paper covering their method of diagnosis, treatment, and management of skin cancer. They emphasize the importance of a biopsy as an aid in correct treatment, and discuss treatment from a surgical and irradiation viewpoint. Their studies indicate that the failures to cure are frequently due to either inadequate surgery or ir-

radiation. They discuss the quality of radiation and clearly explain what may be expected from either soft or hard rays. They indicate a preference for x-ray over radium. They emphasize the importance of a proper follow-up system, and the frequent examination of the patient which, if carefully done, will naturally improve the results.

In their conclusions they state that accurate diagnosis is essential, that distinction must be made between rodent and epidermoid carcinoma, that skill and thoroughness are required, and that a conscientious follow-up is of greatest importance.

JAMES J. CLARK, M.D.

Lupus Vulgaris and the Significance of Certain Non-specific Eruptions in Relationship to Tuberculosis. J. E. McGlashan. Med. Jour. Australia, **1**, 607–611, April 2, 1938.

The author discusses the specific tuberculous skin lesions, the cutaneous tuberculides (Darier), and the hypodermic tuberculides with regard to their bacteriology, histology and microscopic structure, etiology, and results of animal inoculation. He considers the evidence relating the so-called non-specific lesions to tuberculosis, the information being grouped under the above subheads. The amount of information given in this short article is such that no succinct detailed abstract is possible.

W. H. GILLENTINE, M.D.

Herpes and Physiotherapy. Serret. Bull. et mém. Soc. de Radiol. Méd. de France, **25**, 773–775, November, 1937.

The sufferer from herpes is too frequently sent to the radiotherapist late in the course of the disease, and radiotherapy in this stage is usually unsuccessful. In the earlier stages of the disease, it is more amenable to radiotherapy. The author cites six cases of his own cured by ultra-violet irradiation in heavy doses. Roentgen therapy has proved equally successful in the hands of others. These cases should be treated in the first 48 hours.

S. R. BEATTY, M.D.

THE STOMACH

Complete Removal of the Stomach for Malignancy: Report of Five Surgically Successful Cases. Frank H. Lahey. Surg., Gynec. and Obst., **67**, 213–223, August, 1938.

The author presents five surgically successful cases of total gastrectomy with full technical details. One patient lived three and one-half years, one has lived nearly a year without evidence of recurrence, one has been but recently operated upon, and two lived six and nine months, respectively. It is felt that the procedure will be occasionally justifiable after the lesion is exposed, its extent determined, and visual metastasis not observed. There are two distinct types of carcinomatous involvement of the stomach. In one, the more common type, the lesion is local, with early and extensive metastatic involvement of the adjacent lymph nodes, usually seen late in its course, and with a discouraging percentage of cures. In the other, the lesion is not local but one in which the growth appears thoroughly to have infiltrated the gastric walls without, however, apparent metastatic lymph node involvement. It is in this type that total gastrectomy is to be considered. While there can be no certainty of determination of operability prior to surgery, in those patients in whom the roentgenologic study and chemistry of the gastric secretions obviously indicate extensive carcinoma of the stomach, but in whom the evidence of secondary effects—cachexia, fixation of the mass, and palpable metastasis are not present, and in whom roentgenology demonstrates a rigid-walled stomach without peristalsis through which the opaque meal rapidly passes, exploration as to the possibility of performing total gastrectomy is distinctly justifiable.

W. R. BROOKSHER, M.D.

Mucosal Pattern Technic and Kymographic Records of the Esophagus and Stomach. Edward H. Skinner. Jour. Am. Med. Assn., **109**, 1963–1965, Dec. 11, 1937.

The mucosal pattern, the relief picture, or the compression technic of the mucous lining of the gastrointestinal tract, is secured by fluoroscope or roentgenogram after manipulation and gravity have adapted a thin, mucilaginous, opaque medium to the mucosal folds of the esophagus, stomach, small or large intestine. It is a study of the intimate morphologic detail of the mucosa. It amplifies the routine examination in certain details of the actual ulcer and cancer or characteristic diagnostic patterns, such as esophageal varices or chronic gastritis. Special apparatus is required (1) so that the favorable mucosal pattern can be achieved by compression, position, and posture, and (2) so that the small, aimed roentgenograms are secured at the right instant. The expense of this technical requirement seems to preclude the adoption of this technic by others than roentgenologists. There are inherent dangers to the roentgenologist in the mucosal pattern technic because of the prolonged exposure of the fluoroscopic studies which may be necessary to secure or identify the favorable filling, or pattern, which he wishes to record permanently, by the roentgenogram. Sometimes this danger is greatly increased among physicians who complete their own roentgenographic examinations, because they fail to impose on themselves the requirements of eye accommodation, because they do not have the apparatus that roentgenologists know is essential for success with this method and, more pertinently, because they lack a studied familiarity and experience with normal and abnormal mucosal patterns.

Two situations of practical and easy application of pattern technic involve (1) the lower end of the esophagus and (2) the general mucosal pattern of the stomach.

Kymography contrasts with the mucosal pattern technic in that it is entirely a record of function ex-

hibited at a chosen margin of an organ. The value of kymography in gastric diagnosis would be for the study of the muscular movements of a portion of the wall where one suspected an early cancer. Enthusiasm for gastric kymography is not warranted. The theoretical possibilities are overshadowed by an actual danger of technic and physiologic embarrassments to interpretation.

CHARLES G. SUTHERLAND, M.D.

THE THYROID

Roentgen Therapy of Basedow's Disease. D. Negru. Strahlentherapie, **62**, 450, 1938.

The author reviews the pathogenesis and pathologic anatomy, history of roentgen therapy, mechanism of effect of irradiation, technics advocated by a number of radiologists, and the results reported in the literature. The various objections to roentgen therapy, as, for instance, development of adhesions and injuries to skin and larynx and the occurrence of myxedema, are outlined and contradicted. The indications and contraindications to irradiation as set forth by a selected number of investigators are quoted. In the author's own clinic, 428 cases were treated during the period 1922–1937: 77.5 per cent were women and 22.5 per cent men. The majority were between 20 and 50 years of age. During that time the technic varied considerably; now the author prefers a radiation produced at 160 kv., filtered through 0.5 mm. Cu + 4 mm. Al, with 200 r per sitting. He applies five sittings over the anterior thyroid and thymus and two lateral areas over each lobe. There are three or four days between sittings. The same area is treated again after seven days. One series takes 14 days; there are intervals of from four to six weeks between series, with a maximum of three series for the individual case. Of the 295 cases that could be followed only partially, the results were: 7 per cent cured, 22 per cent considerably improved, 55 per cent improved, and 16 per cent failures. This material, however, is not suitable for definite conclusions because most patients had received inadequate treatment. A series of 50 cases that received sufficient therapy and could be followed up for a period of from one to ten years showed that 36 per cent were cured for anywhere from one to ten years; 32 per cent were markedly improved for from one to six years; 22 per cent were improved for from one to three years, and 10 per cent, reexamined one to five years after the treatment, were failures. Only one single case of myxedema was seen following radiation therapy in the period of 15 years.

After a critical analysis of this material, the author reaches certain conclusions. He believes that one-third of an erythema dose per sitting should not be exceeded. The thymus should be included in the irradiated area. Filtration should be chosen according to the size of the goiter, although no definite difference could be seen between filtration of 4 mm. Al or 0.5 mm. Cu + 4 mm. Al. It takes at least three series, applied during a period of four months, in order to decide whether or not x-ray therapy may be of benefit in a particular case. No injuries to the skin or larynx nor adhesions of the thyroid are seen, provided that the treatment was skillfully applied. Since roentgen therapy is a relatively harmless method it should be given a trial in all cases.

Contra-indications acceptable to the author are patients with compression symptoms, suspicion of malignant degeneration, and toxic adenoma with highly toxic symptoms from the beginning of the disease. Roentgen therapy should be discontinued as soon as the basal metabolic rate drops to +10 per cent. Roentgen therapy seems to offer 40 per cent cures in all cases, while those cured and those improved reach a total of 80 per cent. The author considers that in 10 per cent recurrences may be expected.

ERNST A. POHLE, M.D., Ph.D.

TUBERCULOSIS, PULMONARY

The Lasting Cure of Early Pulmonary Tuberculosis. J. Burns Amberson, Jr. Jour. Am. Med. Assn., **109**, 1949–1952, Dec. 11, 1937.

There are seven reasons for directing attention again to the early tuberculous lesion and its cure. The nature of the early lesion is better understood now than ever before. The time of life when the lesion is most likely to appear is more clearly defined. The methods of diagnosing its presence have been developed and perfected. The subsequent behavior of the early lesion and the ways of its healing and advancement are better known. Most disabling and fatal tuberculosis originates in this lesion. Knowledge of the methods of treatment and their proper selection and application is more accurate and reliable. The far-reaching and vastly superior results of proper and timely treatment of the early lesion are firmly established.

The development of the early lesion, often called the early infiltration, may be rather abrupt, that is, within a week or a month, or it may be gradual with static periods of apparent quiescence. The patient has no symptoms or only slight to moderate constitutional ones, chiefly a loss of a few pounds of weight and a little undue fatigue. More often the physical examination reveals nothing abnormal in the chest. The roentgenogram shows, as a rule, the small area of soft infiltration in one lung. Tuberculosis takes its heaviest toll between the ages of 18 and 35. No age is immune from this danger.

The early lesion will be discovered in only a small minority of cases unless this disease is viewed as a community problem and organized searches for it are made periodically. The physician, in his capacity as a far-seeing health officer, must seek the patient. Tuberculin testing and x-ray examination of the chest, wisely planned and applied, are indispensable parts of the diagnostic method.

Rigid and prompt treatment of the early infiltration, as it appears especially in young people, with a preliminary period of from two to four months' bed rest, has

proved to be the most effective in terms of lasting recovery and avoidance of advanced relapsing disease.

CHARLES G. SUTHERLAND, M.D.

Roentgenologic Study of Isolated Form of Pulmonary Tuberculosis. S. H. Wang, C. L. Hsu, and C. Wu. Chinese Med. Jour., **52**, 817–829, December, 1937.

The authors define the form of tuberculosis first described by Assmann and termed by him "initial tuberculous infiltrate" as "the isolated form of pulmonary tuberculosis." The typical lesion is sharply circumscribed, usually round, may be in the initial, or calcified stage, and is usually unassociated with the enlargement of the tracheo-bronchial glands which is found only in childhood or initial types of the disease.

The authors found 50 cases of the isolated form in 2,000 cases of pulmonary tuberculosis of all forms. It is two or three times more frequent between the ages of 20 and 29 than any other form of tuberculosis. The sex incidence in general is similar to that in other types of tuberculosis.

Serial roentgenologic observations form the only basis for prognosis in this type of lesion. The condition must be differentiated from the metastatic neoplasms, parasitic infestations such as the cysticercus, paragonimus, and the hydatid cyst as well as from metastatic pulmonary abscesses.

W. H. GILLENTINE, M.D.

VISCERA, TRANSPOSITION

Congenital Dextrocardia with Complete Transposition of Viscera: Report of Case. Christy Y. D. Tyau. Chinese Med. Jour., **52**, 439–442, September, 1937.

Although dextrocardia with transposition of viscera has been known for a long time, it was not until 1928 that a case was reported in China.

The relative incidence of transposition discovered varies with the method of examination employed, as follows:

Roentgen ray	1: 1,400
Postmortem	1: 5,000
Dissecting room	1:10,000
Physical examination	1:35,000

The essayist reports a new case and in his comments states: "The greatest liability to error occurs when one examines acute abdominal cases without careful and thorough examination of the whole body, especially the heart. With such abnormal condition, the left-sided liver may be mistaken for splenic enlargement. An acute lesion of the transposed appendix may be wrongly diagnosed as diverticulitis or, in a woman, as tubal-overian disease or salpingitis. Palamountain reported a case that was diagnosed as left tubal gestation, but, upon operation, it turned out to be a gangrenous transposed appendix."

A. MAYORAL, M.D.
